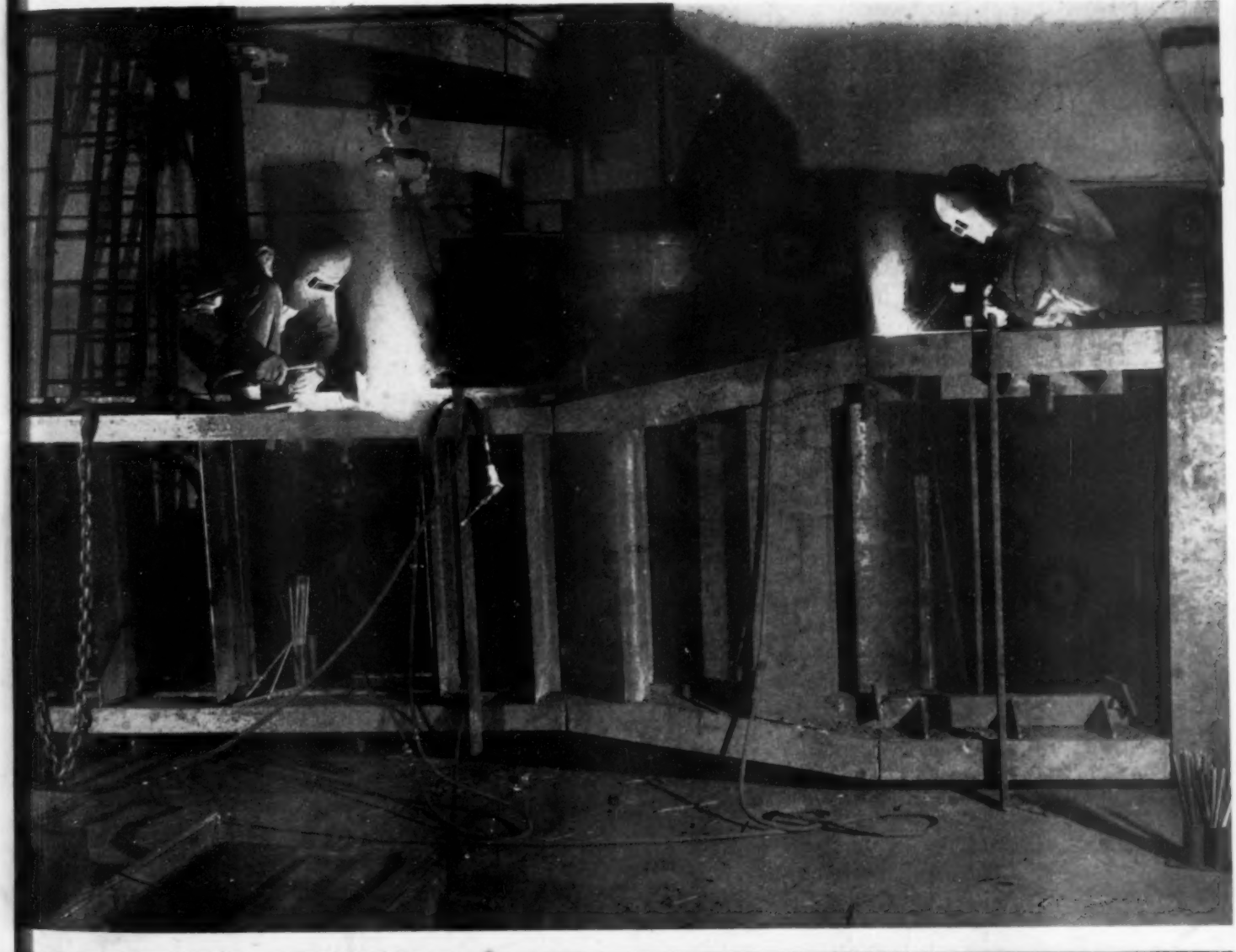
MAY, 1948

The WELDING Journal



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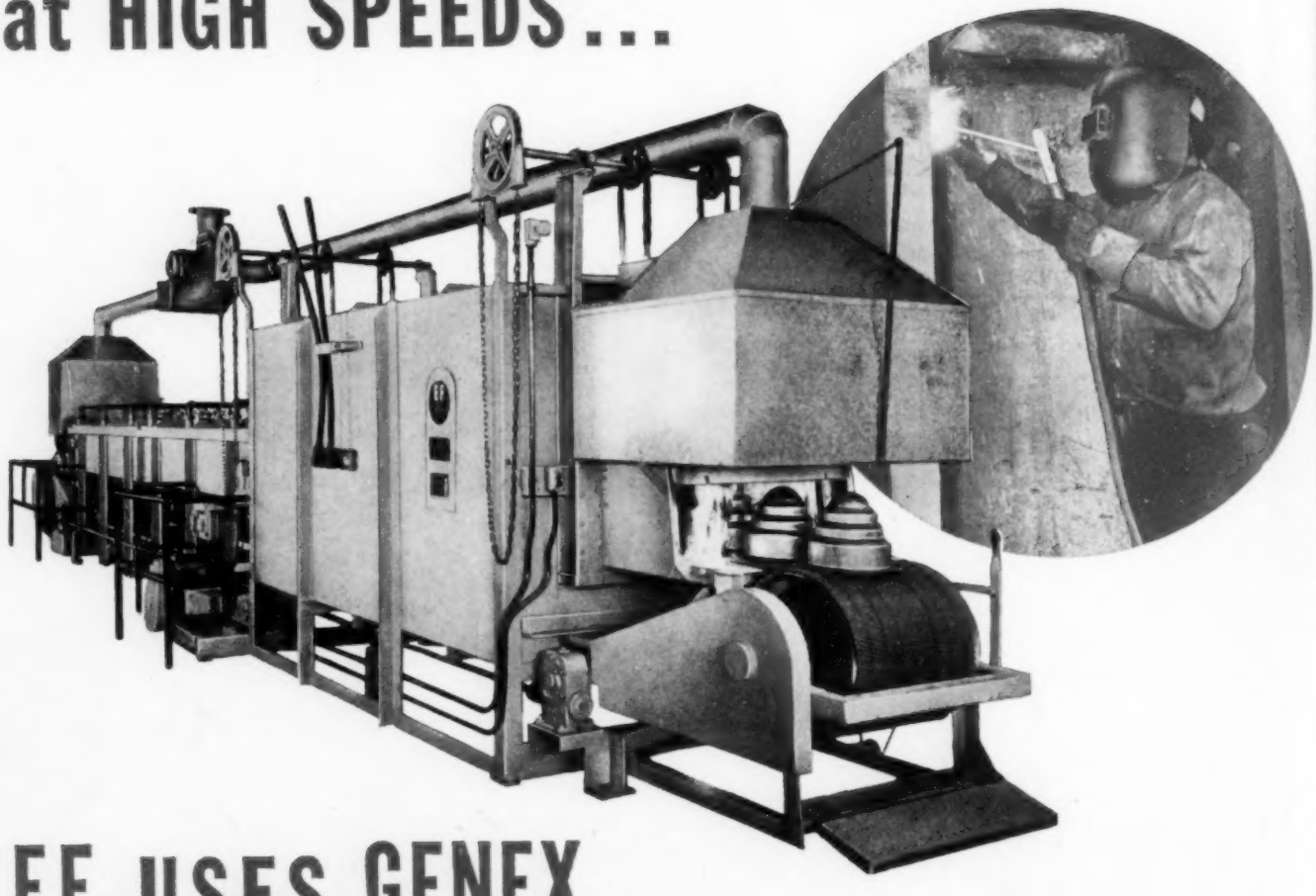

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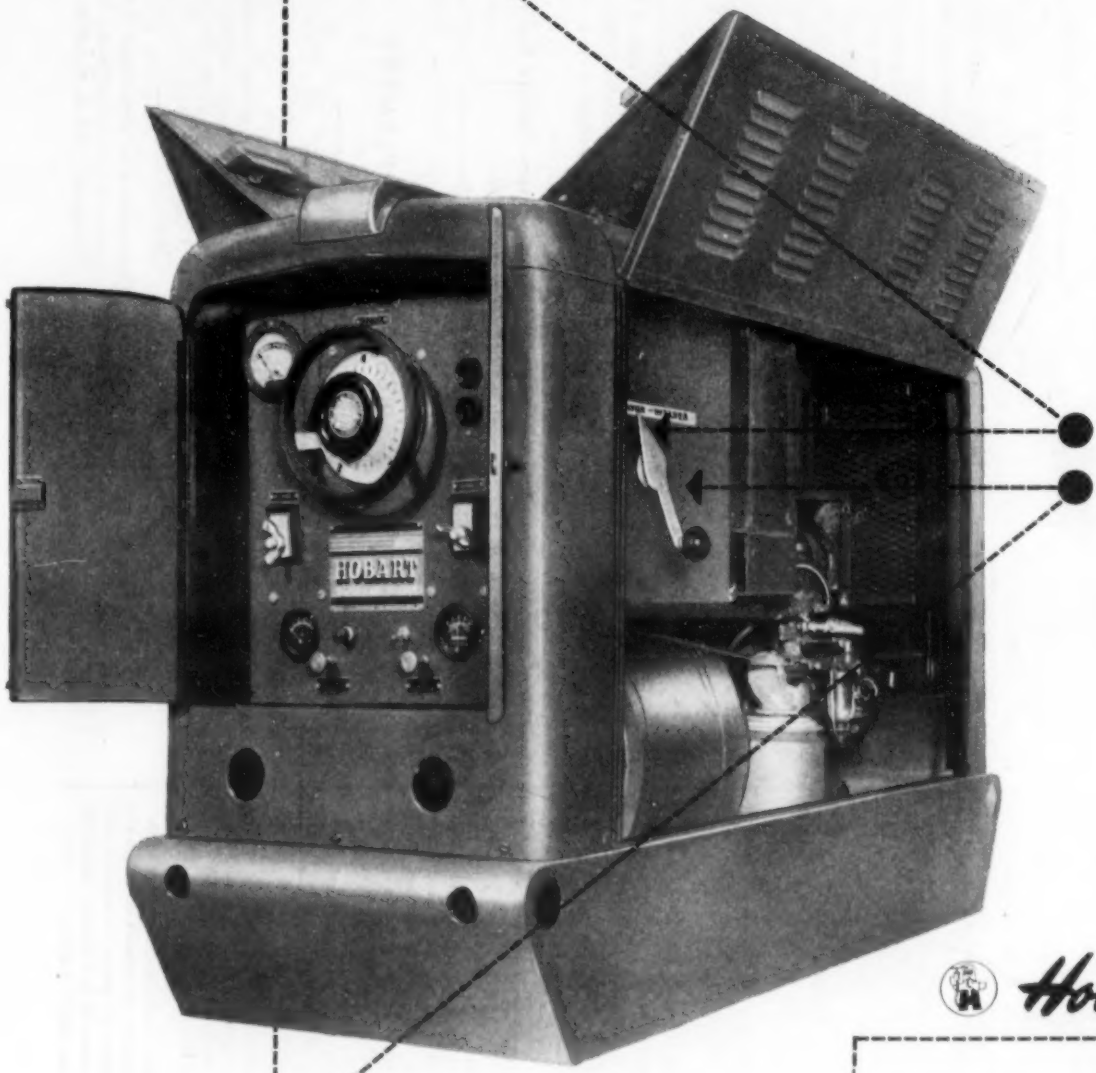

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COVER

Arcwelding Diesel Engine Base at the Vargo-Weld Corporation's Cleveland Plant. *Courtesy of Air Reduction Sales Company.*

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Recommended Practices for Salvaging Automotive Gray Iron Castings by Welding

A Committee Report

NOTE: This Report has not received final approval as yet. It is being published in THE WELDING JOURNAL for the purpose of securing comments, criticisms and suggestions.

To be considered, these should be addressed to S. A. Greenberg, Secretary, Automotive Welding Committee, AMERICAN WELDING SOCIETY, 33 W. 39th St., New York 18, N. Y., and should be received not later than JUNE 15, 1948.

FOREWORD

THIS standard was promulgated by the AMERICAN WELDING SOCIETY Automotive Welding Committee. It is based on a survey of cast-iron welding practices employed throughout the automotive industry.

Effort is made to cover all practices successfully employed and to point out where possible the obvious advantages and disadvantages of each. It is not intended that these recommended practices be used as a standard for use in the welding department but rather as a guide to establishment of such shop standards.

The recommendations are designed primarily for the use of those units of industry which are engaged in producing or machining new automotive gray iron castings.

Welding such as outlined here is employed to varying degrees in different plants. In some organizations welding is not used to its full advantage, due to arbitrary restrictions which may be based on part failures as a result of faulty procedures.

It is hoped that publication of the information contained herein will call attention to the welding of castings so that those concerned will recognize the fact that a definite amount of welding has its place in the economy of automotive fabrication.

SECTION I—GENERAL

101. Repairable Defects

A wide variety of casting defects, such as cracks and machining errors, can be successfully repaired by welding. In general, repair by welding is indicated when a technique can be established that does not impair the machinability or serviceability of the casting. Cracks, strains, warpage, hard spots, softening, loss of strength, etc., are impairments resulting from faulty procedure.

The amount of welding necessary is the chief criterion determining whether a specific defect can satisfactorily be welded. It not only determines the economy of repairing as compared with recasting, but also influences the choice of method.

The location of a flaw in a casting, the amounts of machining that have been completed, equipment and skill available further decide the practicability of repairing.

The types of defects usually encountered which may be repaired by welding or related processes (see Appendix) are misruns, cold shuts, laps, blowholes, cracks, porosity, etc. In addition broken-off portions, mismachined dimensions, tool gouges, etc., are repairable, within limitations.

The extent to which repairs may be made and the choice of method are discussed in Section IV. However, these are general rules; the extent to which defects may be repaired on a specific casting can only be determined by trial and error. Once that extent has been determined, it is necessary to establish detailed procedures for each part number. Examples of these procedures or Shop Standards are illustrated in Section VI. A typical automotive cylinder block is shown in Fig. 1.

102. Inspection

A competent castings inspector is essential. He should know the welding procedures involved.

His task is to make decisions on the following questions:

"Does it need repair?"
"Would it be more desirable to recast?"
"Which repair method?"

Most defects are found on visual inspection of rough castings after sandblasting. Adequate lighting is essential for this purpose. The defects found should be clearly marked and the casting routed to the repair welding department.

Castings that must be leak proof in service are water tested in addition. This is necessary to detect leaks resulting from cracks and porosity, some of which cannot be detected visually. Leak tests are made by filling a casting with water or air under pressure. When air is used the casting is usually immersed although soapy water is sometimes "painted" on the surface. Leak tests should also be made after repair welding in order to find any cracks resulting from the welding operation.

Cracks are readily found by the kerosene and chalk method which consists of wetting the suspected area with kerosene or mineral spirits, wiping dry the surface, and rubbing the area with blue chalk.

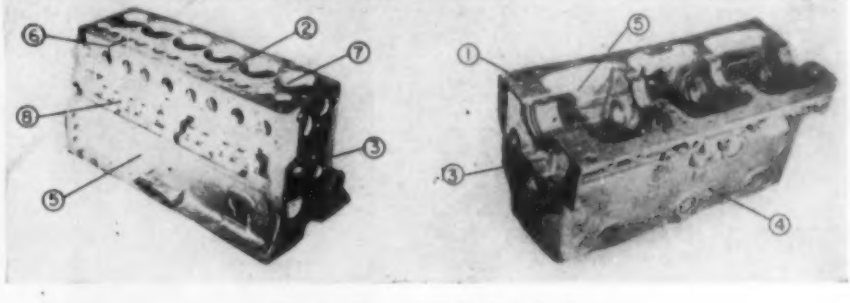


Fig. 1—Typical Cylinder Block

1, Flange; *2*, Top Face; *3*, Front, Rear Faces; *4*, Side Wall (Water Jacket); *5*, Crankcase; *6*, Exhaust, Intake Ports; *7*, Cylinder Bores; *8*, Tappet Chamber.

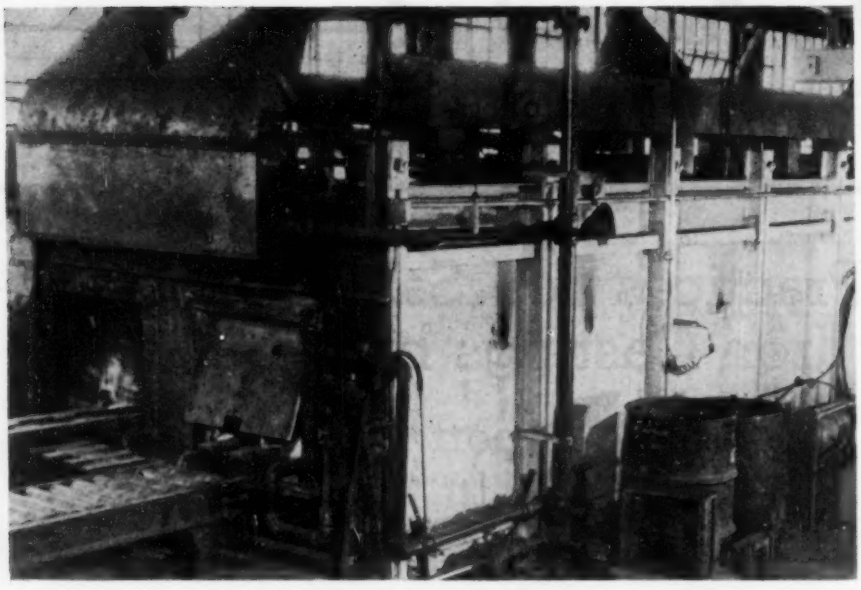


Fig. 2—Furnace Designed for Preheating and Postheating Cylinder Blocks

The liquid in any crack will flow out, wet the chalk, and show up as a dark line.

Magnetic inspection, acid etching and X-ray are of value for occasional quality control. These inspection techniques together with metallurgical examination are also used for proving new procedures.

103. Preparation

The preparation of defects for repair welding involves the opening up of any cavity and the removal of any sand therein. This operation may be performed either by flame gouging or chipping and grinding.

Flame gouging, i.e., melting out defects by means of a torch, is most commonly employed where the defect is to be gas welded immediately. If the defects contain sand, a skilled operator can judge by the color of the flame when it has been completely removed. Flame gouging should not be used on restrained areas without general preheat. Since flame gouging tends to hide rather than remove defects, chipping and grinding is sometimes used instead. However, it, too, tends to hide cracks.

Holes should be drilled beyond the ends of a crack to prevent its extension during grinding and welding. A "U" groove should be ground along the length of the crack.

Small defects, such as sand holes, etc., are more easily welded if the metal removed in preparing for welding is kept at a minimum. This can be more easily done if proper tools are available to the welding operator. A right-angle drill with rotary files is essential.

Prior to welding, the area surrounding the defect should be cleaned of sand, oil, water, etc.

SECTION II—GRADES OF CAST IRON

201. Cast Iron

Cast iron is a complex alloy of iron, carbon and other elements. The carbon content varies from 1.7 to 4.5%. Most commercial grades, however, have between 2.5 and 3.5% carbon. It is this high carbon content which makes the material easy to cast.

202. Gray Cast Iron

Above the critical temperature of cast iron which averages around 1300° F., all the carbon present is combined with the iron forming iron carbide. As a casting cools below this temperature at a slow rate, most of the carbon separates into small flakes of graphite. These graphite flakes weaken the iron in proportion to their size and number. At the same time they permit easier machining. The gray appearance of a fresh fracture on this type of casting is responsible for the term "gray iron."

203. White Cast Iron

When cast iron cools very rapidly from above the critical temperature, the carbon remains combined with the iron. A fractured surface has a white appearance and is, therefore, called "white cast iron." In this condition, cast iron is extremely hard and brittle and cannot be machined.

204. Malleable Cast Iron

When white cast iron is given a special annealing heat treatment, all the combined carbon separates into small rounded bits of carbon called "temper carbon." This leaves the remaining iron free or nearly free of combined carbon. In this form, carbon does not harden or embrittle the metal and leaves it in a malleable condition.

205. Effects of Alloying Elements

Besides carbon, cast iron also contains varying amounts of other elements. The more important of these are silicon, manganese, sulphur and phosphorus. In addition, some alloy cast irons contain chromium, nickel, molybdenum and other alloying elements. The percentage of each is controlled to impart definite properties to the iron.

Silicon increases the fluidity of cast iron and on cooling increases the rate of separation of carbon. This latter effect results in softer weld deposits when high silicon filler metal is used.

Manganese has a slightly opposite effect to that of silicon.

Sulphur tends to hold the carbon in the combined form, thereby increasing the hardness and brittleness.

Phosphorus increases the fluidity of molten iron; therefore, it is added to cast iron welding rod when increased fluidity is desired.

Chromium, nickel, molybdenum and other alloying elements are added for a variety of reasons. The important effect of their presence on welding is the greater tendency for hardening in and adjacent to weld deposits.

206. Effects of Welding

As in welding any metal, the effects of the heating and cooling incident to welding must be considered. Since cast iron has a very low ductility it will not withstand any appreciable stress. The exact effect of welding on a cast-iron part depends on the temperature to which the area adjacent to

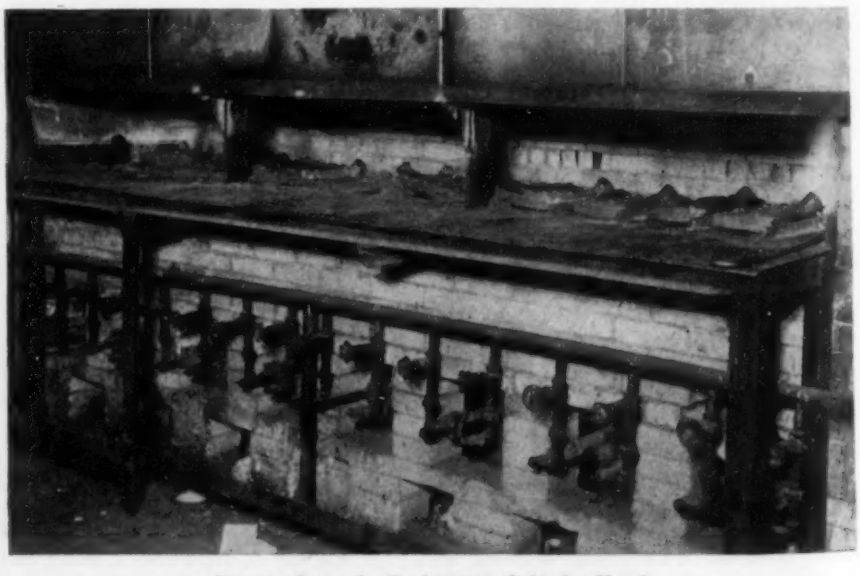
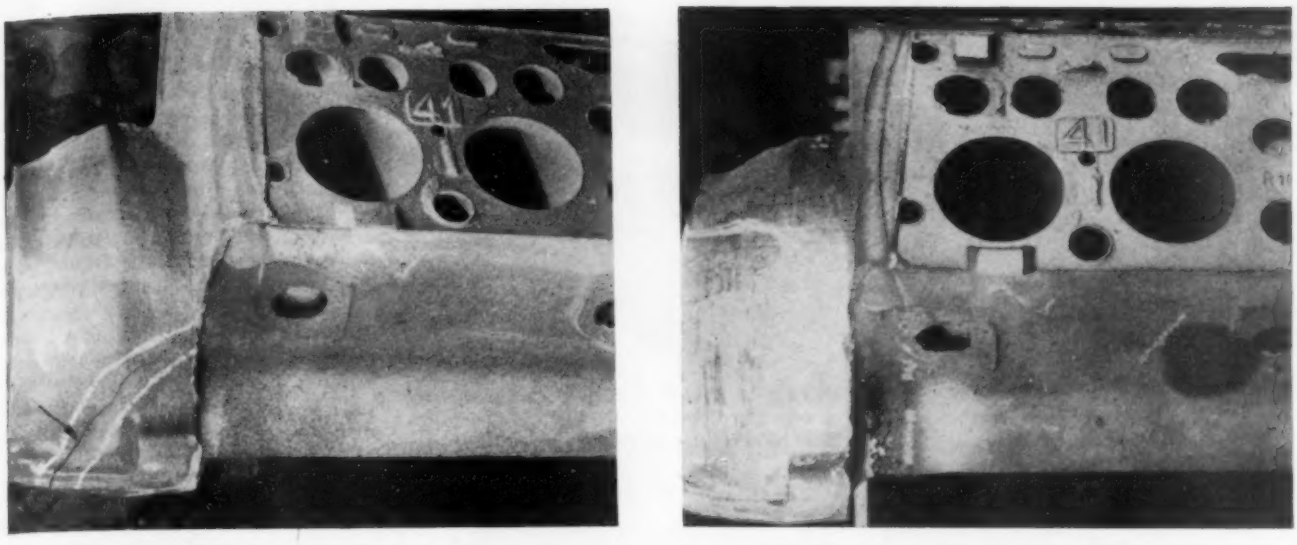


Fig. 3—Setup for Preheating Cylinder Heads



(A) Crack in rough block

(B) Crack repaired by oxyacetylene welding

Fig. 4—Repair of Cylinder Block

the weld is heated and the extent of this area. For best results it is desirable to keep the temperature as low as possible, and the area heated as small as possible. Of course some increase in temperature is necessary if welding is to be used to effect a repair. However, the heated area can be reduced by the choice of arc welding rather than gas welding. Nonferrous electrodes are of still further aid.

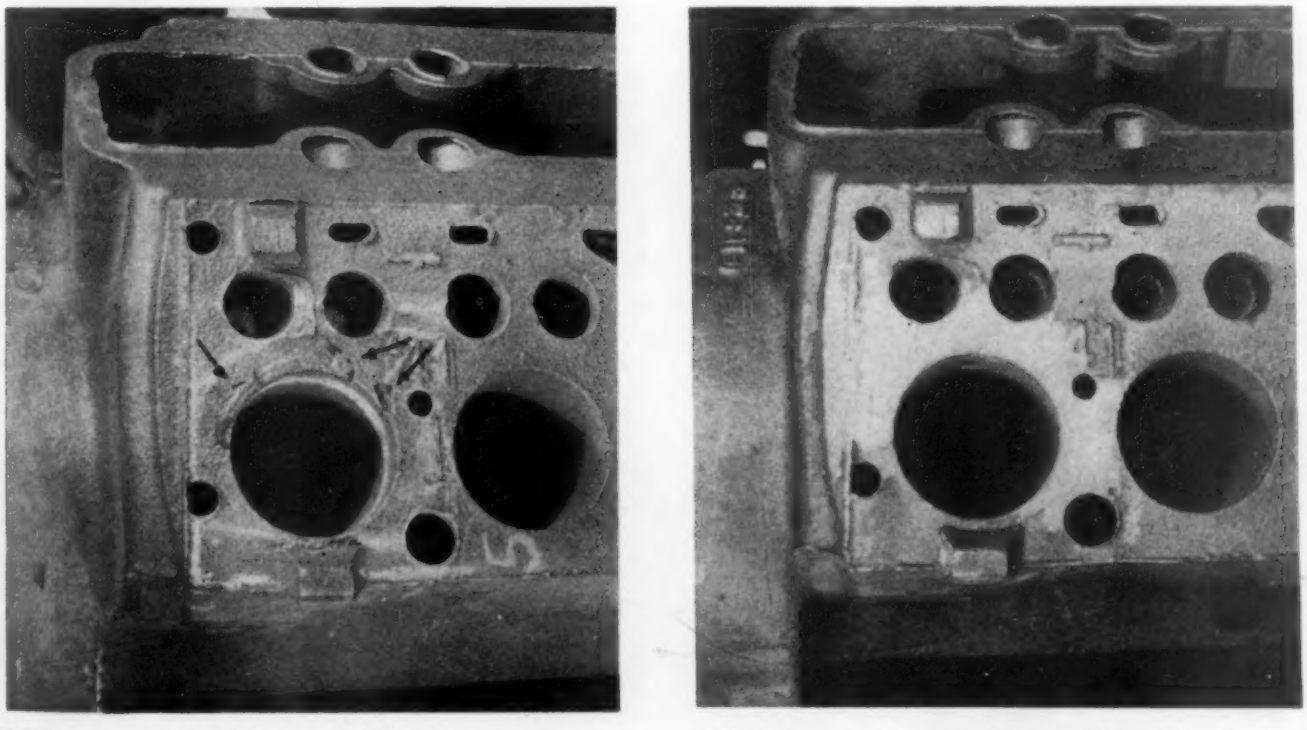
However, since it is the difference in temperature between the weld area and the surrounding cold area which causes variable expansion and hence cracking, another solution is to preheat the part and therefore expand the adjacent metal also. A local preheat may suffice but a general preheat is sometimes required.

Contraction on cooling may also induce cracks. A molten weld deposit undergoes considerable contraction when solidifying and cooling to room temperature. Rupture of the metal may result immediately or may occur after the part is put into service. Slow cooling or stress relief followed by slow cooling is necessary to prevent this possibility.

Nickel and nickel alloy rods are also effective in minimizing cracks resulting from shrinkage stresses since these materials stretch considerably. Moreover peening may be used with these metals to force movement of weld metal so as to remove strain.

The rate of cooling affects the hardness in and adjacent to welds. As mentioned in Articles 202 and 203, white cast iron forms at welds when a critical cooling rate is exceeded. Increasing the silicon content of the welding rod, and reducing the cooling rate, reduce this effect. Also subsequent annealing may be used to lessen hardness for machining.

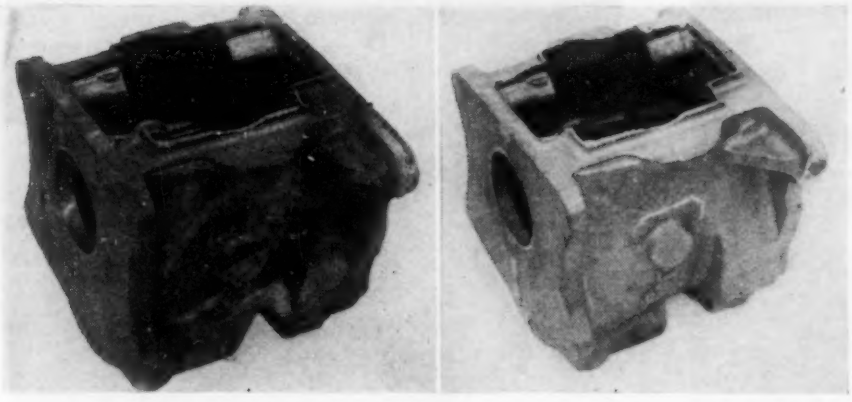
Another factor to be considered when cast iron is welded is growth of dimension from precipitation of graphite during prolonged heating particularly at the high heat and longer time required for gas weld-



(A) Defect in rough block

(B) Defect repaired by oxyacetylene welding with preheat and postheat

Fig. 5—Repair of Cylinder Block



(*A*) Defective boss (*B*) Boss repaired by oxyacetylene welding

Fig. 6—Transmission Case Housing

ing. Hence, welds should be made quickly.

Higher strength cast irons may lose their strength as a result of excessive preheat or stress-relief temperatures. A maximum safe temperature should be determined prior to establishing a procedure.

SECTION III—PREHEAT AND STRESS RELIEF

301. General Preheat

General preheat is required when any amount of welding is to be done on a restrained portion of a casting.

The purpose of preheating is twofold. First, it reduces the rate of cooling, thereby lessening the tendency for hard spots to form at the welds and, second, it minimizes localized expansion and contraction which induce cracking. Usually it is more satisfactory and more economical to preheat entire castings. However, since a general preheat results in some movement and consequent loss of dimension, its use is limited to unmachined or partially machined castings.

The rate at which a given casting can be brought to preheat temperature and allowed to cool therefrom is dependent upon the uniformity of heating in the furnace and the form of the casting. Castings can be heated more uniformly by a continuous preheating furnace. Such furnaces (See Fig. 2) are constructed so that castings can be preheated when fed from the cold end to the hot end and stress relieved by passing in the opposite direction in the same furnace.

A preheat temperature between 1000 and 1050° F. is recommended for ordinary gray-iron parts. The limiting maximum temperature on any particular grade of cast iron is the temperature at which it begins to lose strength or hardness. This temperature should be determined for the iron used and a safety factor of at least 50° F. deducted therefrom.

302. Local Preheat

Local preheating involves heating a casting in the area of repair welding only. A welding torch or a gas burner is used for this purpose.

Local preheat is most commonly employed on partially or completely machined castings where general preheat cannot be used due to danger of dimensional changes through warpage. (See Fig. 3.) It cannot be used on portions of castings that are restrained from expansion, since cracks or stresses, which may cause cracks later, will probably result. Generally, its use is limited to corners, edges, bosses, etc. A skillful and conscientious operator is needed to avoid overheating and misapplication of the heat to restrained areas.

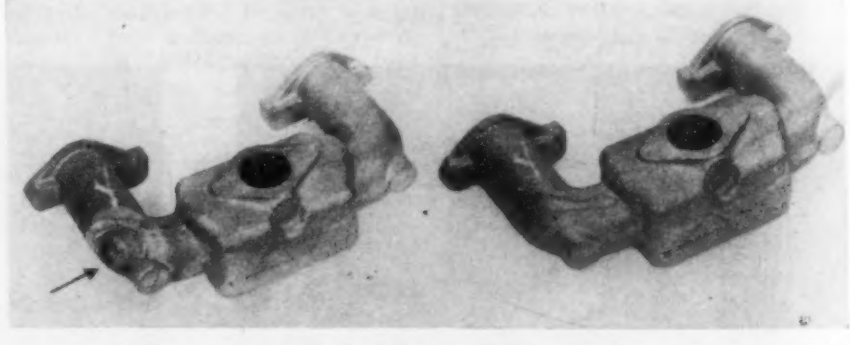
After completing a weld, the flame should be held on the casting for a sufficient time to prevent local hardening. Too rapid cooling after the flame is removed should be prevented.

High hardness due to arc-welded repairs can be diminished by local preheating. A temperature range of 300 to 400° F. is of some value but at least 1000° F. is desirable if the heat-affected zone is to be machined on high-production machine tools.

303. Stress Relief

The rapid expansion and contraction resulting from repair welding develop stresses which may, if of sufficient magnitude, either distort or crack highly restrained castings. Cracking may occur either during welding or after a part is put into service.

Adequate preheat tends to minimize stresses but too rapid cooling after welding can also produce stresses. In order to overcome this difficulty it is necessary to subject some castings to a stress-relief heat treatment.



(*A*) Dirt or slag in wall (*B*) Cleaned and repaired by oxyacetylene welding

Fig. 7—Intake Manifold

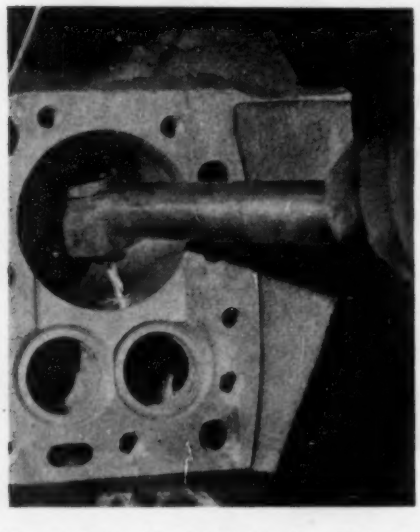
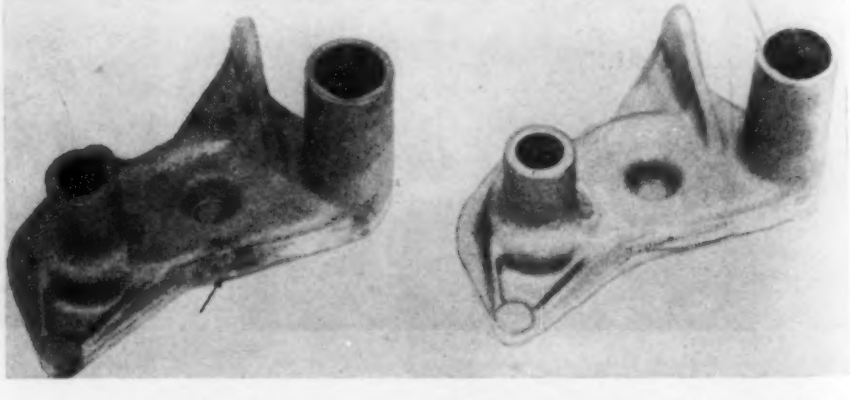


Fig. 8—Cleaning Out Defect in Cylinder Bore



(*A*) Slag or dirt hole (*B*) Cleaned and repaired by arc welding

Fig. 9—Water Pump Housing

Stress relief must begin before a casting has cooled too far from the minimum welding temperature. A recommended minimum is 750° F. Cooling during welding can be delayed by the use of a flexible asbestos shield. This not only stops drafts but also keeps radiant heat from the welding operator.

The maximum stress relief temperature, like the maximum preheat temperature, is also limited to a high point which will not soften castings. For ordinary gray iron a safe range is 1000–1050° F. For other grades the range should be determined from the analysis or by experimentation.

The general practice is to allow castings to remain at 1050° F. long enough to become uniformly heated and then to cool down at least to 500° F. in the furnace, allowing two hours' time plus one hour additional time for each $^1/_2$ in. thickness over 1 in.

However, all castings, whether welded or not, contain locked-in stresses, and since the purpose of stress relief is to reduce stresses below the danger point, the above rates may be increased in many instances.

SECTION IV—METHODS OF REPAIR WELDING

401. General

A number of factors dictate the particular method to be used for a specific repair. Among them are the following:

(*a*) Condition of casting—rough or machined.
(*b*) Location of defect.
(*c*) Size and nature of defect.
(*d*) Need for color match.

402. Oxyacetylene Welding with Furnace Preheat and Postheat

Oxyacetylene welding with furnace preheat and postheat is the most frequently used method for repair of castings. It is usually employed on rough castings, particularly in areas where localized heating would tend to produce cracking. With suitable skill and technique this method may be used for a considerable amount of repair on a casting.

Procedure

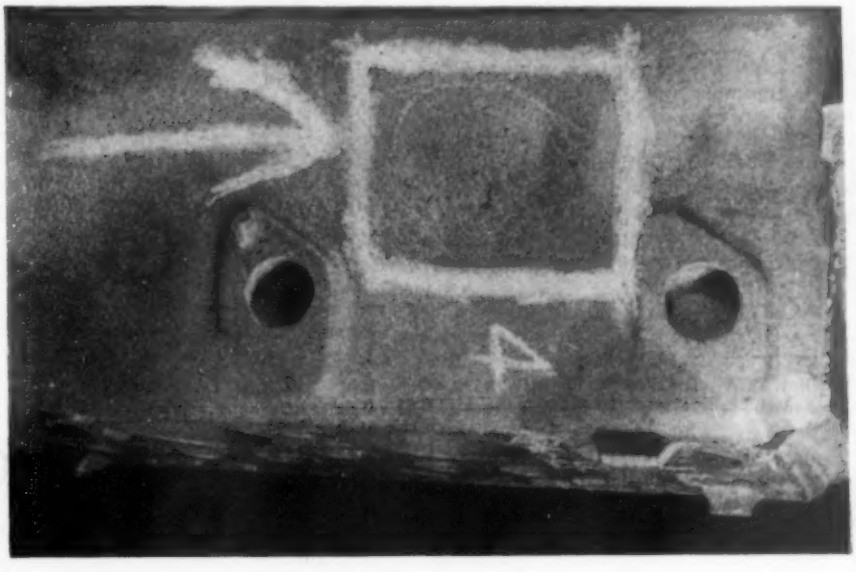
1. Indicate defect with heat-resisting chalk or other marking device.
2. Chip or grind, etc., if required (see Article 103).
3. Preheat (see Article 301).
4. Gouge out if necessary.
5. Weld immediately on removal from furnace using a neutral or slightly carburizing flame. A suitable flux must be used. This flux should provide adequate flotation, fluidity or puddling to produce welds that are sound and free of slag or gas inclusions. Sprinkle flux in the defect and the bottom of the cavity. Melt the metal of the outer walls of the vee ahead of the metal at the root, to assure thorough fusion at the root. The rod, dipped in flux, should be brought to a red heat and rubbed into the molten metal. Molten metal should never be dropped into the puddle if slag inclusions are to be avoided, nor should a cold welding rod be plunged into the puddle if hard spots are to be avoided. When the surface of the metal appears dirty, a small quantity of flux should be added. The tip of the blue cone of the flame should be kept from $^3/_{16}$ to $^7/_8$ in. away from the molten puddle to avoid hard spots and loss of silicon and carbon. The rod should have an analysis within the ranges specified in Article 502.
6. Stress relieve (see Article 302).
7. Chip flux deposit and grind weld flush with surface of casting.
8. Reinspect.

403. Oxyacetylene Welding with Local Preheat and Postheat

This procedure involves welding a defect after local preheating of the area around the repair only. It is used on corners, bosses, etc. It must not be used on restrained areas or on machined parts where warpage might be detrimental. Local preheat is usually done with either the welding torch or a special burner. (See Article 302.)

Procedure

1. Preheat area containing defect to 1000–1050° F. (dull red color) with torch or burner.
2. Clean defect (if not mechanically cleaned) by flame gouging with torch.
3. Gas weld with oxyacetylene torch using technique described in section 402.
4. Postheat surrounding area to 1000° F. and hold at temperature for



(*A*) Excessive porosity

(*B*) Metal spraying defective area

Fig. 10—Repairing a Defect by Metallizing

one minute. Delay cooling rate with shield to stop drafts.

5. Chip flux deposit and grind weld flush with desired contour.
6. Reinspect.

Typical defects repaired by oxyacetylene welding are shown in Figs. 4 to 7.

404. Manual Arc Welding

Certain small defects are more feasibly repaired by manual arc welding. On machined castings such as blocks where preheating and stress relieving would cause warpage, this is the only method that can be used except for an occasional corner, boss, flange, etc., where gas is used. Defects are prepared by hand grinding, chipping, drilling, etc. (see Article 103 and Fig. 8).

The following types of electrodes are used for manual arc welding:

Cast Iron Core Electrodes.—Manual arc welding with electrodes having a cast-iron core involves the highest heat input of all the electrodes listed here. It is, therefore, used primarily on preheated parts. Where a number of small flaws are to be corrected, it is faster than gas welding. Defects must be prepared prior to welding, usually by mechanical means. Since the torch is generally used for local preheating and flame gouging, it is easier to continue with the torch and gas weld most defects.

Steel Electrodes.—Coated electrodes having a mild steel core are used to a comparatively slight degree. They are used for small pits and cracks. The deposited metal mixes with some cast iron forming a very hard spot which must be annealed to relieve strains and to soften for machining. The strains are high from steel electrode deposits. This increases the probability of cracking. For these reasons mild steel electrodes are not generally recommended for repair of new castings.

Coated Nickel and Monel Electrodes.—Heavily coated pure nickel core electrodes are used for repairing miscellaneous small casting defects, machining errors, etc. They may be used at nearly all locations of castings including machined surfaces. The heat-affected zone is slight and may be machined with difficulty. The deposit is easily machinable. A preheat of 300° F. aids in reducing the hardened zone but a local postheat of 1000° F. is necessary to restore good machinability. Low-amperage a. c. or reversed polarity d. c. is used. Beads are deposited in short lengths which are peened and allowed to cool before the next increment of weld. Monel core wire is used in a manner similar to nickel core wire.

Bare Nickel Electrodes.—Bare nickel electrodes are employed in two similar procedures for making small repairs particularly in bores where the almost complete absence of a heat-affected zone is desired. The first method is sometimes improperly referred to as "cold welding" or "battery welding." It employs a high amperage (approximately 350 amp.) with a sufficiently low voltage (6 to 12 v.) to make it impossible to hold an arc. The current is usually obtained from batteries. Metal is deposited by a "scratching" action. This method requires operator skill to secure a fair bond and obtain a deposit free from flakiness and porosity. Peening is used extensively to obtain sound deposits.

Bare nickel electrodes are also used in a similar process known as "intermittent welding." Current is obtained from a special transformer wherein it is interrupted periodically by a contactor to prevent the generation of high heat. This method is preferred over the former. Repairs can be made faster; the bond is better; and the deposit is sounder. A special grinder is made use of in removing excess filler metal in bore repairs. It is designed to grind down to the bore wall without touching it so that rehoning will finish the task.

Other Nonferrous Electrodes.—Several nonferrous electrodes are used including a coated copper sheathed nickel core electrode and others. These permit the use of slightly different current characteristics.

Figure 9 illustrates a typical defect repaired by arc welding.

405. Brazing

Brazing is occasionally used instead of welding where a lack of color match is permissible. It is employed for defects on bosses, corners, edges, etc., similar to gas welding with local preheat. It requires less preheat and repairs can therefore be made with greater freedom from warpage and cracking.

Procedure

1. Thoroughly clean area around defect.
2. Preheat area to a cherry-red, approximately 1000° F.
3. Use a slightly oxidizing flame. The flux should be oxidizing in character in order to remove graphite which will hinder the tinning of the cast iron by the graphite. Tin surface with a well-fluxed rod, then apply sufficient metal to repair defect.
4. Allow casting to cool slowly.
5. Grind flush.

SECTION V—MATERIALS USED

501. General

A number of welding rods and electrodes are offered for cast-iron welding. Some of the more widely used in the automotive industry are listed here. This list is not all inclusive and many materials which are not listed are satisfactory.

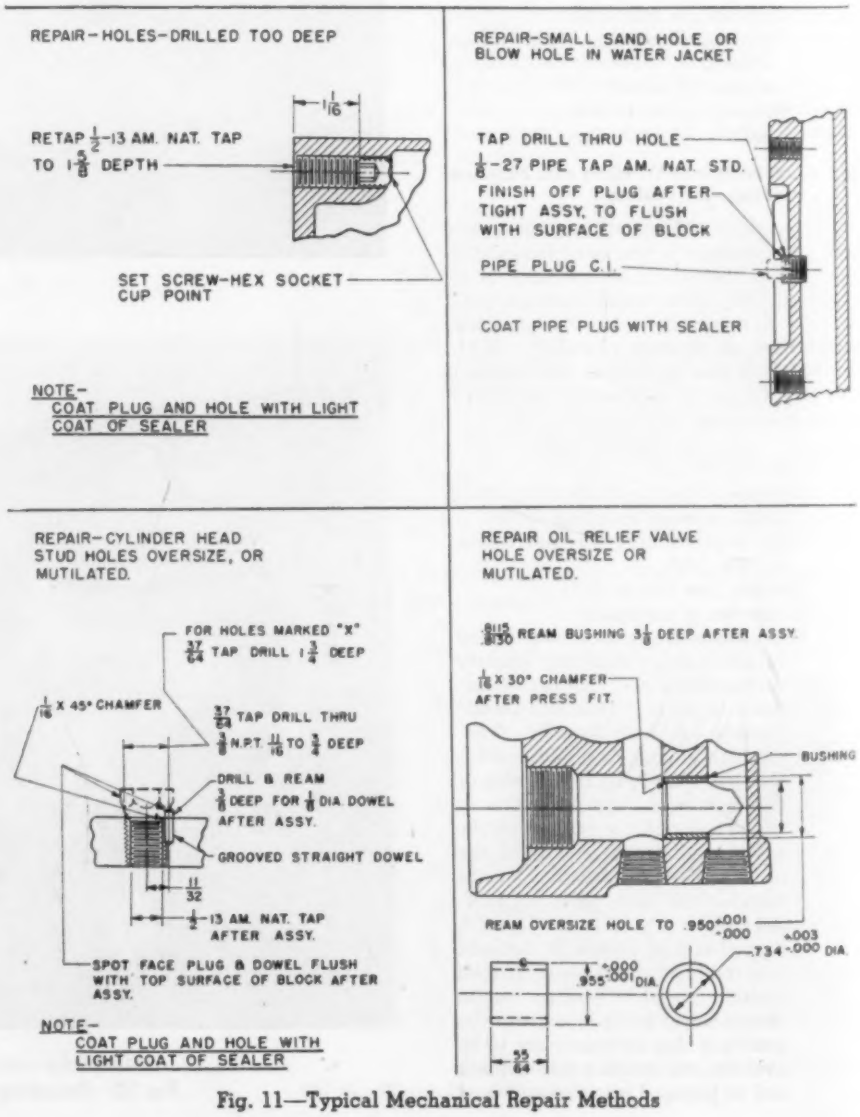

REPAIR-HOLES-DRILLED TOO DEEP
RETAP 1/2-13 AM. NAT. TAP TO 1 5/8 DEPTH
1 1/16
SET SCREW-HEX SOCKET CUP POINT
NOTE- COAT PLUG AND HOLE WITH LIGHT COAT OF SEALER
REPAIR-SMALL SAND HOLE OR BLOW HOLE IN WATER JACKET
TAP DRILL THRU HOLE
1/8-27 PIPE TAP AM. NAT. STD.
FINISH OFF PLUG AFTER TIGHT ASSY. TO FLUSH WITH SURFACE OF BLOCK
PIPE PLUG C.I.
COAT PIPE PLUG WITH SEALER
REPAIR-CYLINDER HEAD STUD HOLES OVERSIZE, OR MUTILATED.
FOR HOLES MARKED "X" 37/64 TAP DRILL 1 3/4 DEEP
1/16 X 45° CHAMFER
37/64 TAP DRILL THRU
3/8 N.P.T. 11/16 TO 3/4 DEEP
DRILL & REAM 3/8 DEEP FOR 1/8 DIA. DOWEL AFTER ASSY.
GROOVED STRAIGHT DOWEL
11/32
1/4-13 AM. NAT. TAP AFTER ASSY.
SPOT FACE PLUG & DOWEL FLUSH WITH TOP SURFACE OF BLOCK AFTER ASSY.
NOTE- COAT PLUG AND HOLE WITH LIGHT COAT OF SEALER
REPAIR OIL RELIEF VALVE HOLE OVERSIZE OR MUTILATED.
8115/8130 REAM BUSHING 3 1/8 DEEP AFTER ASSY.
1/16 X 30° CHAMFER AFTER PRESS FIT
BUSHING
REAM OVERSIZE HOLE TO .950 +.001 -.000
+.003 .734 -.000 DIA.
+.000 .955 -.001 DIA
55/64

Fig. 11—Typical Mechanical Repair Methods

502. Cast-Iron Filler Metal

The following chemical ranges are recommended for gray cast-iron repair welding. No. 1 is used where a more fluid metal is desired. No. 2 is more suitable for build ups.

	No. 1	No. 2
Carbon	3.20–3.70	3.20–3.70
Manganese	0.50–0.75	0.50–0.75
Phosphorus	0.50–0.75	0.55 max.
Sulphur	0.12 max.	0.12 max.
Silicon	2.75–3.50	2.75–3.50

503. Nonferrous Electrodes

Bare nickel—commercially pure nickel—annealed.

Coated nickel—coated pure nickel.

Coated monel—nickel 65–70%. Copper 25% min., other elements 5.0% max.

504. Hard Solder

Analysis approximately:

Tin 0.35%, Lead 0.30%, Zinc 0.35%.

SECTION VI—WELDING STANDARDS

601. General

Repair standards for a particular welding shop should be written especially for that shop. Due consideration should be given to the type of castings repaired, the volume of work done, and the equipment available.

602. Typical Standards

As a guide the following is a typical shop standard for unmachined cylinder block repair:

Location	Defect	Method	Limitation
1. Water jacket	Blows Dirt Cracks Chills	Gas weld—furnace preheat and postheat or arc weld	Not larger than 1/2 in. Cracks under 2 in.
	Porous metal	Seal or metal spray	
2. Crankcase	Blows Dirt Cracks Chills Breaks	Gas weld—furnace preheat and postheat or arc weld	1 in. maximum dimension
	Porous metal	Seal or metal spray	
3. Top face	Blows Dirt Cracks Chills Breaks	Gas weld—furnace preheat and postheat or arc weld—local preheat	1 in. maximum
4. Exhaust and intake ports	Blows Dirt Cracks Chills Breaks	Gas weld—furnace preheat and postheat or arc weld—local preheat	1 in. maximum
5. Bearings	Blows Dirt Cracks Chills	Gas weld—furnace preheat and postheat	1 in. maximum
6. Cylinder walls	Blows Dirt	Gas weld—furnace preheat and postheat	1/2 in. maximum
7. Spring housing	Blows Dirt Cracks Chills	Gas weld—furnace preheat and postheat	1 in. maximum
8. Manifold	Blows Dirt Cracks Chills	Gas weld or arc weld	1 in. maximum

APPENDIX—OTHER REPAIR METHODS

701. General

Welding is used interchangeably with other nonwelding repair processes. In some instances welding is used together with a nonwelding process. Among these supplementary repair methods are soldering, metallizing, the use of sealants, and such mechanical methods as plugging, bushing, etc.

702. Soldering

Cast-iron defects are occasionally repaired by soldering with hard, high-zinc solder. This method is employed for correction of imperfections on machined surfaces, where gaskets require a smooth surface. This method is being replaced by welding with nickel electrodes (see article 404) in most instances. However, it does have an advantage of speed for some of the larger defects on machined surfaces.

Procedure.

1. Clean defect to sound metal.
2. Flux with raw hydrochloric acid.
3. Apply solder. Solder used must melt over 700° F. and may be heated with soldering iron or torch. Searing by use of oxidizing torch flame aids wetting of solder by burning out graphite.

   The analysis, 30% Lead, 35% Tin, 35% Zinc has been found satisfactory.
4. Finish by grinding.

703. Metallizing

Metallizing is useful for sealing porous defects on areas which will not be subsequently machined to seal porosity which may exist in welded repairs and to seal around plugged sand holes. The wall must meet the specified thickness at the repaired area. A typical repair by metallizing is shown in Fig. 10.

Procedure

1. Thoroughly clean grease, water, dirt, etc., from surface to be sprayed.
2. Shot blast area using S.A.E. G16 split grit.
3. Apply a smooth, uniform coat of copper, 0.005–0.010 in. thick over repair area, using oxyacetylene metal sprayer and commercially pure copper wire.
4. Apply a smooth, uniform coat of steel, 0.003–0.004 in. thick, over copper sprayed area using oxyacetylene metal sprayer and low-carbon steel wire.
5. Reinspect.

704. Use of Sealants

Porous metal defects located so that metallizing cannot be used may be sealed by means of a sodium silicate penetrant sealing agent. This material may be used on machined blocks without danger of rusting.

Procedure

1. Place in fixture to stop openings and secure connections.
2. Circulate sealing agent suspension through block at 80 psi. and 160–180° F.
3. When liquid appears at outer surface of leaking area, reduce pressure to 40 psi. and circulate till leak stops.
4. Raise pressure to 80 psi. to test.

705. Mechanical Methods

In a number of instances certain mechanical methods of repair are preferred over welding, particularly in the case of threaded and nonthreaded holes and small sand or blowholes in crankcase or water-jacket walls. (See Fig. 11.)

Drilled holes are either plugged or bushed. There must be enough metal around a hole thus repaired to maintain a press fit unless the plug or bushing is held in place with dowels. Defects ordinarily repaired include mismachined holes (oversize, eccentric, out of line, too deep, etc.). Bushings may be threaded or not.

Plugging and bushing is employed for tapped holes as well, but since they require strength to hold screws, studs, etc., the bushing or plug is always threaded and frequently dowelled. Pipe plugs and pipe reducing bushings of several sizes are suitable for a number of repairs. Occasionally holes are drilled and tapped oversize and a special diamond shaped wire spring screwed into the holes to restore the desired dimension.

Sand holes are repaired mechanically by drilling through the casting wall so as to remove the defect. This hole is tapped and plugged with standard pipe plugs which are spotfaced and ground to restore the desired contour. To maintain oil and

water tightness a synthetic latex, oil sealing, cement is used to coat the threads.

Standards should be written covering each specific hole which may be repaired in a casting. These standards must be based on a number of conditions such as the wall thickness, the pressure contained, whether or not a screw or stud is held, etc.

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Discussion of the Paper on the Theory of Oxyarc Cutting*

By D. Rosenthal†

THE author is to be commended for his effort to treat the problem of the oxyarc cutting, a newcomer in the field of welding and cutting, from the theoretical point of view. It is especially gratifying to note that, where the problem is not too complex, as for example in the analysis of the rate of burn-off of the rod, reasonable agreement between experimental and computed values has been obtained. Of especial interest is the fact that the theoretical treatment has led to some important practical rules, as for example in the determination of the optimum current for cutting.

The determination of the *optimum rate* of cutting is of a more complex nature, and here the attempts of the author have been less successful. In the opinion of the discussor the failure to arrive at a satisfactory agreement between experiment and theory is only partly due to the reasons put forward in the paper. The main reason appears to be the fact that one of the important factors has been left out in the analysis of the rate of cutting.

The author states correctly that the speed of cutting in its simplest analysis depends on the rate at which reaction temperature is established at the surface of the plate and *within the plate*. But then he goes on considering only what happens at the surface and concludes that rate at which the surface of the plate can be heated by the arc to 1600° F. should be the major factor determining the speed of cutting mild steel.

Actually the heat supplied by the oxidation within the plate is a no less determining factor in so far as the surface of the plate is concerned, and when the "settled condition"—to use the author's word—has become established, it is probably far more determining than the heat supplied by the arc.

That this is so, is strongly suggested by the inspection of Fig. 5 of the author's paper in which the speed of cutting is plotted against the arc energy in kilowatts. It is seen that as the thickness of the plate increases the influence of the arc energy on the speed of cutting decreases rapidly. This is what should be expected, since the heat of oxidation becomes rapidly a major factor with increasing thickness.

From the above discussion it would seem that a far more satisfactory result could be expected, if the heat of oxidation of the plate were included in the analysis of the speed of cutting.

* Paper by H. C. Campbell, published in October 1947 issue, THE WELDING JOURNAL, pp. 889–903.
† Department of Engineering, U.C.L.A.

D.-C. Resistance Welding Utilizing Kinetic Energy Storage*

By Thomas J. Crawford†

The article describes the various devices and apparatus developed by the Resistance Welding industry for reducing peak power demand and gives details of a new direct current generator operated by a 3 phase motor for meeting this problem.

IN RECENT years most electric utilities have come to realize that resistance welding is often the economic key to the existence of widespread metal fabricating industries and that the total power load from such operations is enough to warrant every effort to service the less directly profitable resistance welding load. Today we generally find a sincere spirit of cooperation evidenced by such companies; but only too often they are physically unable to service conventional resistance welding loads with their voltage drops and high flicker as well as high instantaneous demand.

Over the past decade several expedients have been developed and employed to ameliorate this condition. Massive induction motor driven flywheel alternators have been installed to service single-phase welders directly; electromagnetic and electrostatic stored energy systems were developed and employed, at great expense, during the war to spot weld aluminum; the lead-acid storage battery with a three-phase charger was used for single and multispot welding, flash welding and heavy projection welding; and several systems of polyphase-rectification and inversion or "frequency changing" were developed to use three-phase power to feed the inherently single-phase welding load. Polyphase dry disk rectifiers have also been used. While most of these latter devices involved no element of energy storage, they were able to reduce the kva. load in the welding circuit, by employing low frequencies, and to spread this load more or less uniformly among the three phases so that the apparent three-phase line current could be reduced to about $^1/_4$ of that required to achieve the same result single phase.

All of these methods, however, have serious drawbacks for one reason or another.

The induction motor flywheel alternator system approaches the ideal from technical aspects but suffers from considerations of excessive cost, mass and floor space requirements.

The electromagnetic and electrostatic stored energy systems are expensive to install and/or maintain, and their use is limited practically to single impulse spot welds of rather short weld time duration.

The lead-acid storage battery system is quite practicable and is one of the most flexible since it can be used for single-spot, multispot or projection welding with almost any weld time cycle as well as for flash welding. In the larger capacities (such as 100,000 amp.), however, the battery packs become rather bulky and design of connecting busses is a problem. Largely due to difficulty in properly and reliably controlling the charging equipment, battery maintenance has been rather high and rather erratic—even as with our automobile batteries when we neglect the water level and the voltage regulator.

A few installations of power supply for welding through dry disk rectifiers have been made. These step down three-phase line voltage, through electronically controlled primary circuits, to voltages of the order of 4 to 10 v. which are then rectified through polyphase dry disk rec-

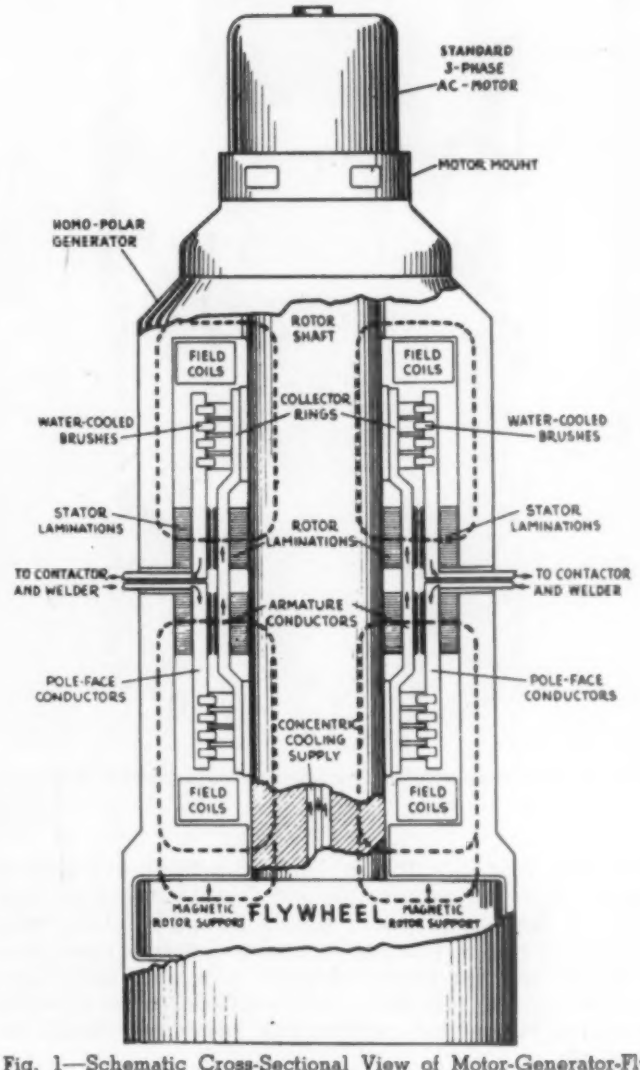


Fig. 1—Schematic Cross-Sectional View of Motor-Generator-Flywheel Unit

* Presented at the Twenty-Eighth Annual Meeting, A.W.S., Chicago, Oct. 18–22, 1947.

† Consulting Engineer, Progressive Welder Co.

tifiers of various types to supply direct current to the welding circuit. This equipment is also expensive and bulky and requires that the line supply all of the welding demand even though this demand is reduced, due to improved power factor.

In recent years it became increasingly apparent that none of the above expedients offered the key to really widespread use of resistance welding in the remote village industry as well as in the great industrial centers. It

Fig. 2—Photograph of the Completed Motor-Generator-Flywheel Unit

was felt that, ideally, resistance welding equipment should be nearly as portable and flexible and require no more in the way of power supply than a machine tool. Simplicity comparable to d.-c. arc welding equipment was desirable and, for small industries in remote areas particularly, it was felt that complicated electronic controls requiring specialized maintenance personnel should be avoided.

Upon examining this problem a few facts stood out:

Fig. 3—Set-up of Generator Unit Powering (Alternately) a R.W.M.A. Size 2 Press Welder and a R.W.M.A. Size 4 Flash Welder

1. Direct current had much in its favor for resistance welding.
2. Stored energy in some form was essential.
3. Utilization of this stored energy should be under more flexible control than the electromagnetic or electrostatic systems permitted.
4. The carbon pile contactor, as developed for and used with the battery welder appeared to offer a practical means for controlling direct current in the welder circuit.

If the battery were to be replaced by some other source of direct current, a generator of some sort was indicated. The commonly used direct-current generator has definite limitations as to current densities in the brushes due to commutation requirements and has troublesome surge characteristics when very heavy loads are rapidly switched on and off. These factors make the size and cost of such a machine excessive if designed for resistance welding loads. Another type of direct-current generator, although not in common use, is actually the oldest and is, perhaps, the only generator of continuous direct current. This is the acyclic or homopolar machine designed originally by Faraday in the form of a

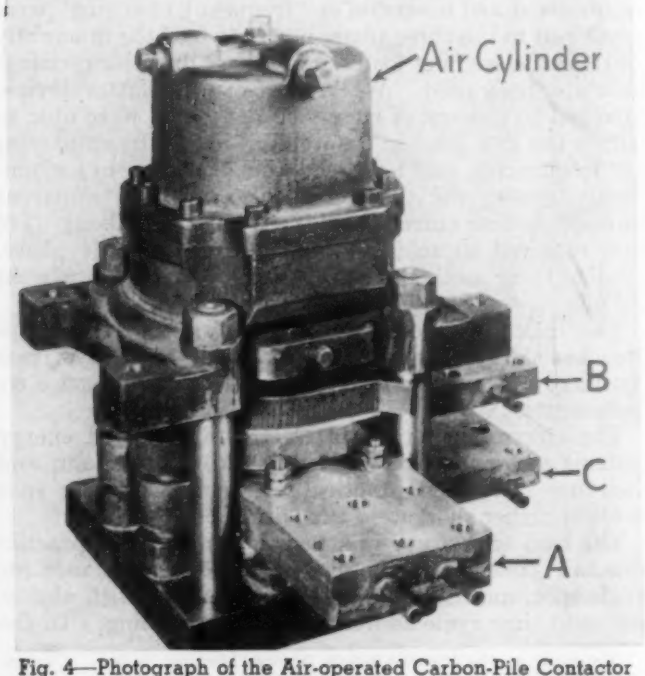


Fig. 4—Photograph of the Air-operated Carbon-Pile Contactor Assembly

copper disk which, when rotated between the poles of a horse-shoe magnet, developed a direct-current voltage between its center and its periphery. This type of machine had notoriously poor voltage regulation under load, due to armature reaction, a particularly bad feature for our purpose. This fault caused the homopolar design to fall into virtual disuse. During the early '30's, however, J. V. Caputo, invented and patented improved methods of compensating such machines, which permitted the design and construction of a unit rated at $7^1/_2$-v., 150,000-amp. continuous duty, which has given excellent performance in the welding of heavy pipe.

A machine employing such principles appeared promising for our purpose and it was decided to design and build a welding power supply incorporating, along with a conventional welder: an induction motor, a flywheel, a compensated homopolar generator and a carbon pile contactor. This project has been completed and the performance of the initial unit has considerably exceeded the original design expectations.

Figure 1 shows the general design of the motor-flywheel generator as developed for our purpose. Due to the fact that the homopolar generator has, effectively, only one armature conductor, the induced voltage for a given speed is determined by the number of lines of flux cut by this conductor each revolution. All of this flux must pass axially along the rotor core through the collector ring and the diameter of the latter must be held down to keep brush velocities within a reasonable range. These considerations led to the design of a machine that is actually two generators back-to-back with their rotors joined axially and their armature conductors joined directly in series so that their induced voltages are additive and each unit needs to develop but half of the required machine voltage.

Referring to Fig. 1, we can see that the generator unit is symmetrical about a horizontal plane through its approximate center. The dotted lines show the field flux linkage paths through each half of the unit and it should be understood that the direction of flux is opposite in the two ends of the rotor so that there is no tendency for interaction between the two magnetic circuits and so that the polarities of the induced voltages make them additive.

Compensation, by the Caputo method previously mentioned, is effected by bringing the brush leads out through pole-face conductors through the stator laminations. It will be seen that load current flowing in these conductors is opposite in direction to that flowing in the armature conductors located close to the air gap on the other side of it. Hence the tendency of the current in the armature bars to rotate, distort or collapse the field flux is substantially canceled by the opposing action of the current in the stator pole-face bars. The use of open slots for the conductors aids this action without changing the induced voltage.

Further, a compounding effect is obtained by skewing the rotor bars between the collector rings and the rotor laminations in such a direction that load current flows partially around the rotor and the consequent ampere turns aid the field excitation coils.

The entire rotating system is carried on two double-row ball bearings; one below the flywheel and the other just below the motor mount ring. The motor itself has no bearings, the rotor being mounted on a stub shaft cantilevered out from the generator rotor.

In order to minimize the thrust load, which is carried

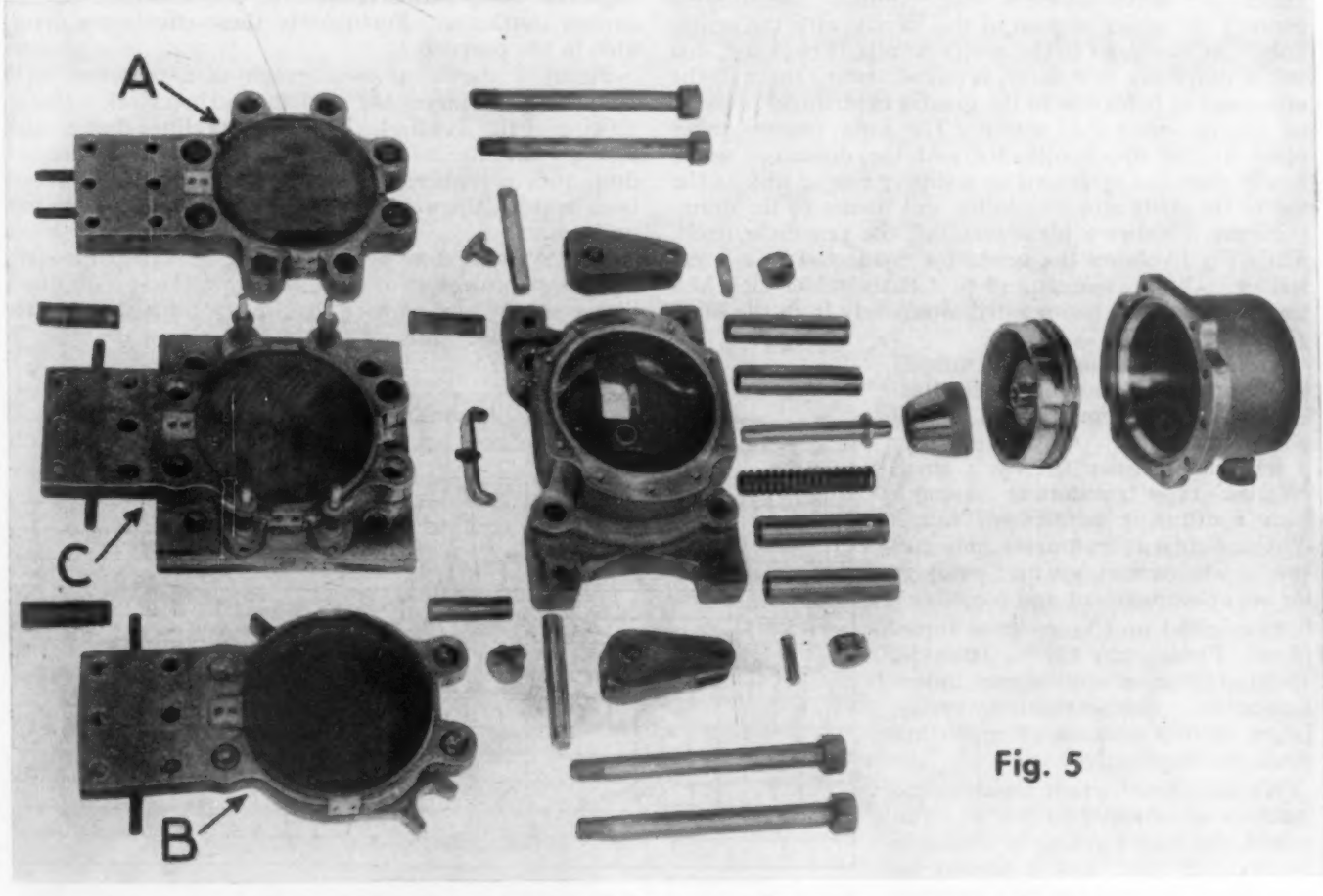


Fig. 5

Fig. 5—"Exploded" View of the Contactor Shown Assembled in Fig. 4

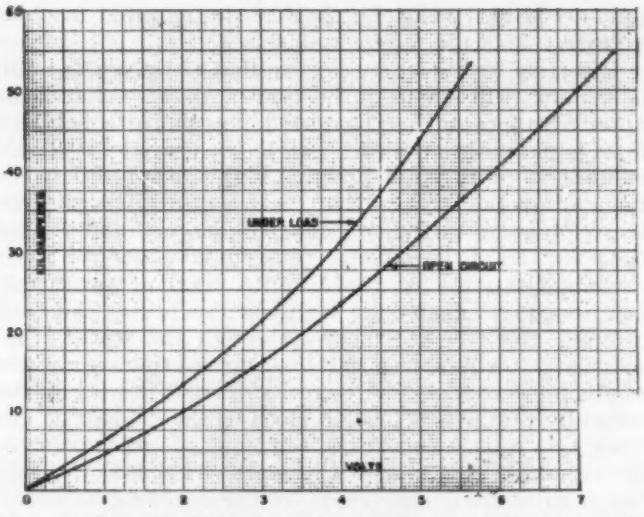


Fig. 6—Terminal Voltage vs. Output Current ("Under Load" Curve) with Curve of Comparable Open-Circuit Voltages

by the bottom bearing, part of the field flux in the bottom unit is allowed to leak into the flywheel and thence to the rotor. This flux produces a lifting force which balances the rotor weight at somewhere near the normal operating field flux value.

Due to the heavy currents carried by the brushes and collectors, these are water-cooled. The brushes, copper-graphite power metallurgy products, are molded and sintered with integral water cooling tubes. The collector rings are cooled by water introduced through a dip tube in the hollow rotor shaft. The incoming water flows up around the dip tube until it encounters radial holes leading to the lower portion of the annular cooling cavity under the lower collector ring. Similar radial holes connect the upper portion of this cavity with the center hole. As the water in the cavity warms, it rises and, due to the difference in density, is forced inward through the upper radial holes due to the greater centrifugal pressure on the incoming cool water. The same process takes place at the upper collector and the discharge water finally rises and is thrown by a slinger ring or disk at the top of the shaft into a collector and thence to the drain.

Figure 2 shows a photograph of the generator itself, while Fig. 3 shows the generator connected to a press welder (RWMA size 2) and to a flash welder (RWMA size 4), which can be operated alternately from the same generator.

Voltage control or "heat control" is obtained by adjusting the field excitation. Excitation current (about 1 k.w. maximum) is obtained from a selenium rectifier fed by a small "Variac" type transformer having a wide continuous adjustment range. A direct-current voltmeter indicates the open circuit output voltage for set-up adjustment and record.

The initial unit employs a three-phase, 4-pole, 220–440-v., 60-cycle, 15-hp., 1700-rpm. squirrel cage induction motor. For heavier duty cycles, larger motors such as 40 or 50 hp. could be employed.

Windage and friction losses in the machine are about 2 to 3 k.w. The rest of the motor rating is available for welding load, and it should be noted that this load can be integrated substantially as a first power function rather than a square function since the rating is not determined by thermal rating of the generator, but rather by horsepower capacity of the motor integrated over a fairly long interval.

By proper choice of motor size and characteristics, and flywheel size, a combination can be matched to almost any program of spot, projection or flash welding within the voltage-current capacity of the machine. This particular generator can supply somewhat more than 50,000 amp. at a terminal voltage under load of about 5.5 v., the open circuit voltage being about 7.0 v. Since the output is direct current, throat area is of little consequence and heavy copper leads can be used due to absence of skin effect.

On the basis of test data from this unit, a smaller unit, of about half the current rating and about 4.5 v. output running at double the speed, has been designed and is now being built. This unit will fit inside the frame of a standard press welder and is expected to show a cost well within economic limits.

The contactor employed to control the generator output is the one previously developed for the storage-battery welder. It has been described elsewhere, but is shown in Figs. 4 and 5 assembled and "exploded." Briefly, it functions by closing two parallel sets of thin carbon plates under high pressure exerted by an air cylinder and bell-crank mechanism. As it opens, the resistance of the carbon contacts increases very greatly before they finally open, so that at the actual "break" the ratio of resistance to inductance of the circuit is quite high and little or no sparking results.

Figure 6 shows voltage vs. short circuit current tests of the generator, contactor and a 30-in. throat press welder. The curvature of the graphs is probably due to nonlinear characteristics of brush contact drop and the negative temperature-resistance characteristic of the carbon contactor. Fortunately these effects are favorable to the purpose.

Figure 7 shows an oscillograph of a pulsation weld made with two pieces of $^3/_{16}$-in. low carbon steel. Due to slowing of the flywheel, the voltage declines during such a long weld interval; but due to decrease in tip contact drop and, probably, contactor voltage drop as the carbons heat up, the welding currents remain quite close to a uniform value.

This system offers a very practical method for spot, multispot, projection or flash welding without requiring a power supply any heavier than that ordinarily used for machine tools.

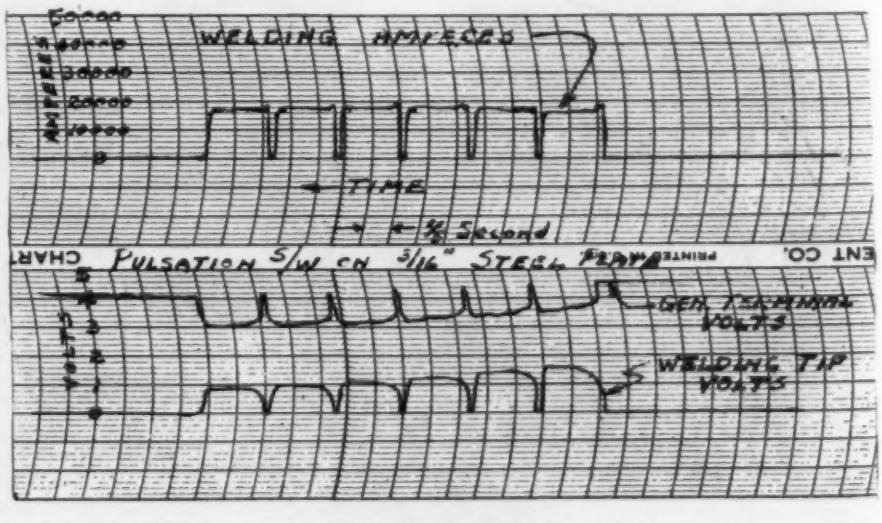


Fig. 7—Oscillogram of Typical Pulsation Spot Weld on $^3/_{16}$-In. Steel Plate. 30-In. Throat Press Welder. (Read from Right to Left.)

Development of Arc-Welded Gas Holder*

By Arthur C. Thompson†

Summary

BARTLETT HAYWARD has been building gas holders since 1876 and has fabricated and erected over six hundred holders ranging in size from 10,000 to 20,000,000 cu. ft. We introduced the steel tank instead of brick tank construction for holders and evolved progressively the first three lift holders followed by the four and five lift holders and later the waterless holder and have constantly led the gas apparatus field with innovations and improvements (Plate I).

While we have utilized welding in the fabrication and erection of complete gas plants, of which we are the leading manufacturer, this article will deal only with the development of one unit of a gas plant—the arc-welded lift-type gas holder. We feel it represents another great stride forward in providing the gas industry with a better product at savings in both cost and time.

* Data and illustrations from a study submitted to The James F. Lincoln Arc Welding Foundation in its recent $200,000 Design-for-Progress Award Program for reports and advances and improvements made by the applications of arc welding in design, fabrication, construction and maintenance.

† Koppers Co., Inc., Baltimore, Md.

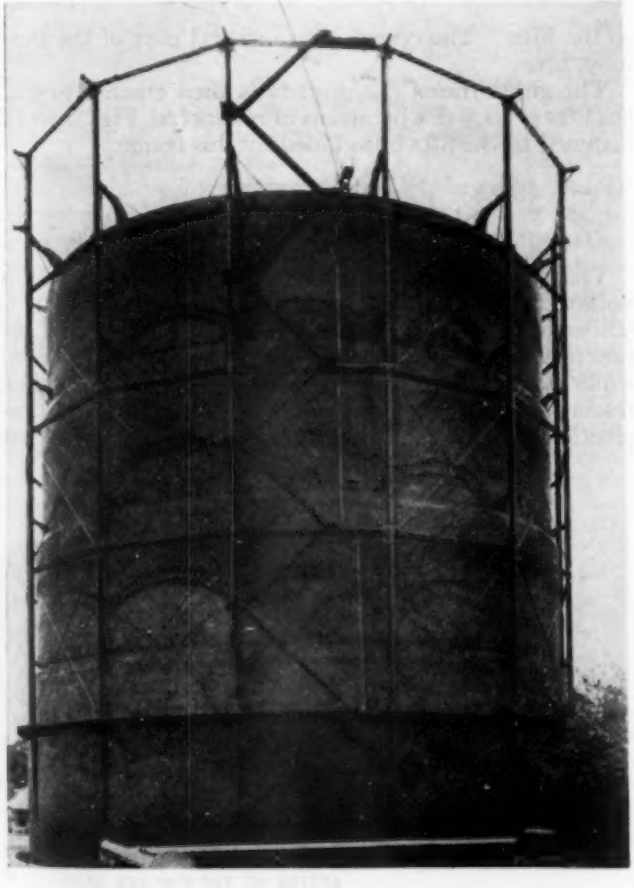


Plate I—Completed All-Welded Lift Type Gas Holder

Redesign from the old riveted construction, using welding and sound engineering, has resulted in lowering the over-all direct cost by 15% (before application of burden), through reduction in weight, freight, shop and field labor, tool costs and engineering, while at the same time increasing strength, durability and resistance to corrosion, with a minimum of maintenance.

This 15% over-all saving occurs as follows: 25% reduction in total shop labor, 12% reduction in material and 23% reduction in field erection labor.

The great portion of this saving is effected through the use, made possible by welding, of large prefabricated bent shell panels, inexpensively formed and easily erected instead of many small riveted plates costly to manufacture and erect. Welding time is reduced to a minimum by a novel method of calking joints to be welded with a nonflammable material, so that the telescopic motion of a lift holder when it is "blown," is utilized to move the work past the welder without first welding the joints on the inside. ("Blowing" is the term used to describe the raising of the lifts by forcing air into the holder by means of large blowers.)

Comparison of the total cost for fabricating and erecting a 2,000,000-cu. ft. four-lift holder, 180 ft. high, with an outside diameter of 144 ft.; is as follows:

	Riveted	Welded	Saving	% Saving
Material	$102,000	$96,000	$6,000	6
Drawings	3,500	3,000	500	14
Shop Labor	33,000	20,000	13,000	39
Freight	16,000	13,500	2,500	15
Erection	66,000	50,000	16,000	24
Miscellaneous, including Painting and 10% Insurance	24,000	24,000	....	..
Tools	13,800	12,000	1,800	13
Total	$258,300	$218,500	$39,800	15

Description of the Product

A gas holder is a container used to store varying quantities of gas at more or less constant pressure. This means, therefore, that as the volume of gas increases or decreases, so must the volume of the container.

There are two methods in common use today for varying container volume. The first is by using a rigid steel shell containing a piston which floats upward as the gas is pumped into the shell. To make the piston gas tight against the shell, a fluid seal is utilized. This consists of a canvas strip, the outer edge of which is fastened to a steel rubbing bar kept in contact with the inner surface of the shell by means of weights and levers. This canvas cup is filled with a sealing liquid (light tar) to a depth equal to about one and one-half times the pressure of the gas beneath the piston. As sealing fluid escapes past the

rubbing bar and falls to the bottom of the holder, a sealant pump returns it to the canvas cup.

The second and older method for varying container volume, and the subject of this paper, is to form the container from a number of sections which fit into each other like the sections of a telescope, the innermost section having a gas-tight top or crown (*58*, Fig. 2) and the other sections being provided with seals. Then as volume of gas increases, the sections telescope up into the air giving more container volume. As the gas volume decreases, the sections slide back into each other, diminishing the container volume. Pressure is not as constant for this type holder since it increases as additional lifts are raised.

Water is used to provide the gas-tight seals between these lifts. This is accomplished by submerging all the lifts in a tank filled with water and providing each lift with a U-shaped cup around the bottom of its circumfer-

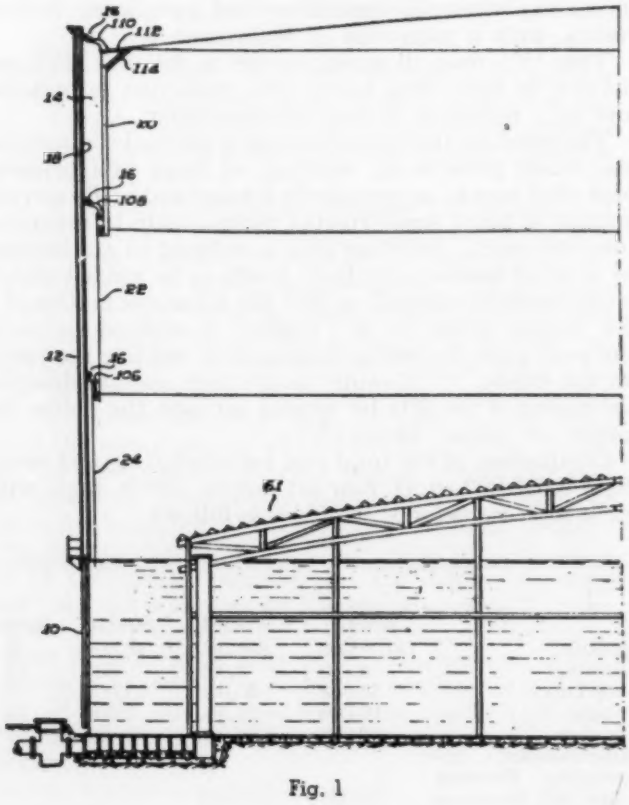


Fig. 1

ence and a U-shaped grip around the top of its circumference. (See Fig. 3, or *40* and *42*, respectively, in Fig. 2.)

When gas is pumped into the innermost lift it begins to float and rises from the water. As its cup (*40*) is about to emerge filled with water, it engages the grip (*42*) on the adjacent lift. This grip, thus immersed in the water retained in the cup, forms a water seal which prevents escape of gas as well as a means to pull the lift into the air. This action takes place successively with the remaining lifts as more and more gas is pumped into the holder until it is completely expanded.

In constructing a lift-type holder, a circular steel bottom is first placed upon a concrete mat. The steel tank is then erected upon the bottom, while at the same time a permanent frame of seasoned timbers and tie rods to support the crown of the innermost lift is constructed on the bottom (*61*, Fig. 1). The cups for the lifts are placed in position and the lift shells are attached to them, using a derrick placed on the crown to lift them. A coping (*12*, Fig. 2) to stiffen the tank is attached to the top circumference of the water tank and the grips are attached

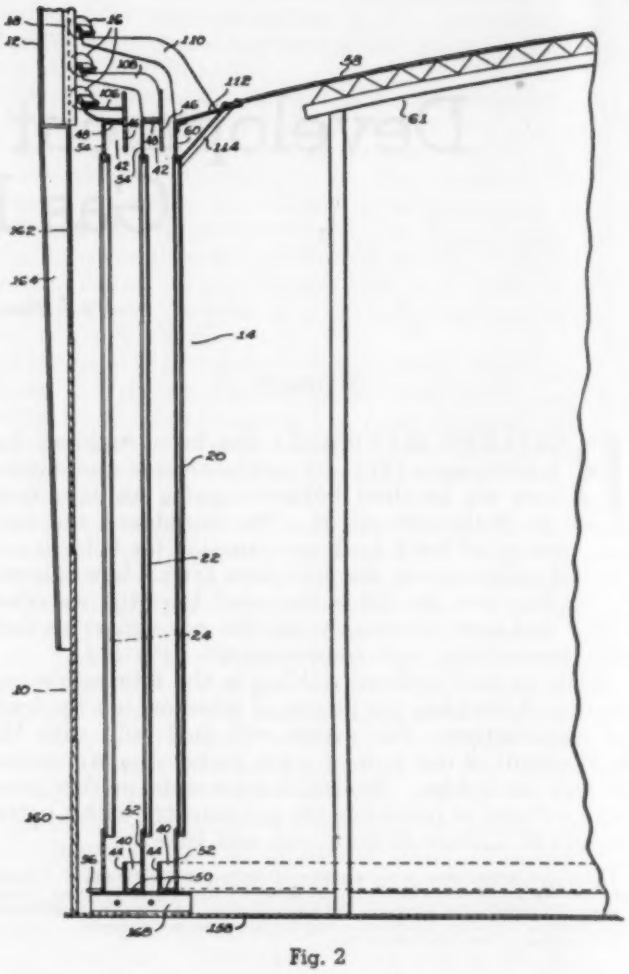


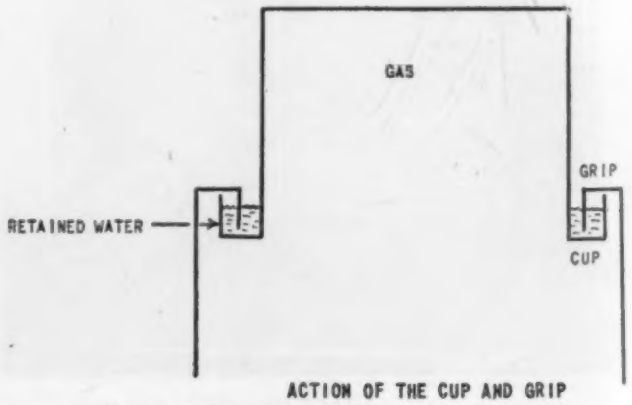
Fig. 2

to the lifts. The crown is an integral part of the innermost lift.

The guide frame (*12*, Fig. 1) is then erected to guide the lifts as they rise by means of rollers (*16*, Figs. 1 and 2), fastened to the lifts but guided by this frame.

Redesign

The redesign from riveted to welded construction involved the complete study of all components of a lift holder from the viewpoint of sound engineering and shop practice in order to produce a better holder at worthwhile savings. This study involved the fabrication and testing of full size sections for strength of joints and easy erection. A complete welding procedure for every joint



ACTION OF THE CUP AND GRIP

Fig. 3

Plate II—Welding Inner Bottom

was then set down for both the shop and field to follow. Only qualified welders are used for both field and shop work.

Savings obtained by welding are most apparent when the costs of the major welded and riveted components are compared. For this purpose, a 2,000,000-cu. ft. holder has been used and the components are presented in approximately the order of erection.

The Bottom

A bottom of riveted construction had to have all plates punched, burred, milled and scarfed in the shop and then be assembled in the field on trestles, be riveted from above and below, be calked and then be dropped to the concrete mat by lowering screws. Welding permits all the plates for what we call the "inner bottom" (Plate II) to be shipped direct to the site of erection from the mill, without first being shipped to the shop for fabrication, which cuts freight cost in half and eliminates application of overhead and four shop operations. In the field, these plates may be assembled directly upon the concrete rather than upon trestles, in overlapping position and fillet welded from above.

The outer bottom is composed of heavier, shaped pieces which have to be burned to size in the shop, as did the riveted plates, but do not need to be punched, burred or milled. When shipped to the field, they are butt welded to each other and fillet welded to the inner bottom. Since the water tank is erected on the outer bottom, butt welding must be used so that outer plates are in one plane. Overlapping plates are not objectionable on the inner bottom, therefore the cheaper fillet welding is permissible. The entire bottom is tested for tightness by a vacuum seam tester which is a box with a rubber gasketed bottom edge and plate glass top. When the weld to be inspected is brushed with soap solution and the box placed over it and evacuted, bubbles will form if there is a leak.

Since we have been welding the bottoms of gas holders for some years, the savings obtained thereby have not been included in the summary of expenses in the summary.

For completeness, the comparison is as follows:

Bottom	Riveted	Welded	Saving	% Saving
Material (including welding Rod or Rivets)	$8,000	$7,000	$1000	12
Shop Labor	1,900	175	1725	91
Freight	1,900	900	1000	5
Field Labor and Miscellaneous	5,500	3,700	1800	33
Total	$17,300	$11,775	$5525	32

Tank Shell

The tank shell for riveted construction was formed of plates milled in the shop, predrilled and rolled to shape

Plate IV—Close Up of Welded Grips

and then shipped to the field where they were riveted with heavy butt straps at the joints. By welding these plates, one shop operation was eliminated and costs were considerably reduced because only planing the edges and rolling to the proper curvature were required. Welding is performed from both sides and all vertical welds must be 100% penetration and horizontal joints 75% penetration and in accordance with the various codes. These welds are rigidly inspected and sections are cut out with a Weld Prober Machine and examined for quality of weld metal. Heavy curb angles were used in riveted construction to fasten the tank plates to the bottom. Welding makes them no longer necessary, saving many pounds of steel (Plate III).

The cost comparison of the two methods is as follows:

	Riveted	Welded	Saving	% Saving
Material	$18,000	$15,000	$3000	16
Shop Labor	3,200	2,300	900	28
Freight	4,300	3,600	700	16
Field Labor	20,000	15,000	5000	20
Total	$45,500	$35,900	$9600	21

Plate III—Erecting First Course of Water Tank

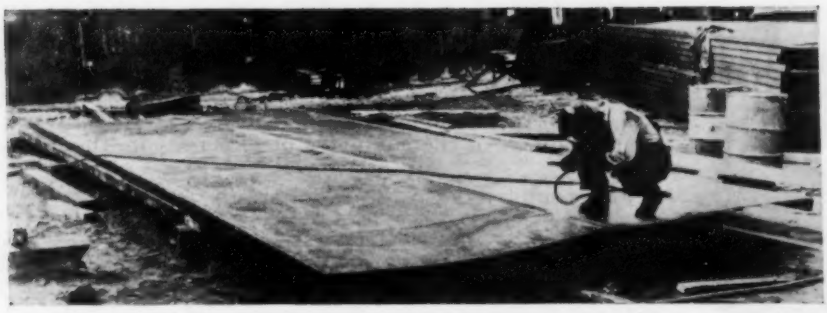


Plate V—Welded Two Panels Together on the Ground

Cups and Grips

No change in design shape was made in converting from riveted to welded construction of cups and grips. The comparison is therefore one of welding design vs. riveting design for the same shaped piece. However, welding large subassemblies in the shop enables easy fast assembly in the field (Plate IV).

	Riveted	Welded	Saving	% Saving
Material	$8,800	$8,800	...	..
Freight	2,400	2,400	...	..
Shop Labor	9,500	7,000	2500	26
Field Labor	4,000	4,000	...	..
Total	$24,700	$22,200	$2500	10

Redesign of Lifts

The redesign of the lifts was the most important from a savings standpoint and at the same time the most interesting.

In the riveted design, the circular lifts or sections of gas holders were made by riveting horizontal shell plates together to form the lift.

The plates measured 3 x 8 ft. and were prepunched in the shop for riveting—one hole every inch. It took, roughly, 560 of these plates to make one lift for a 2,000-000-cu. ft. holder, or the punching of 147,840 holes per lift and, in addition to punching, these plates had to be milled, scarfed and have the burrs ground off and then be shipped to the field for erection.

It was obvious that welding would eliminate the milling, scarfing and burring, as well as most of the hole punching, and that it also offered the possibility of using larger plates if the handling problem could be solved (Plate V).

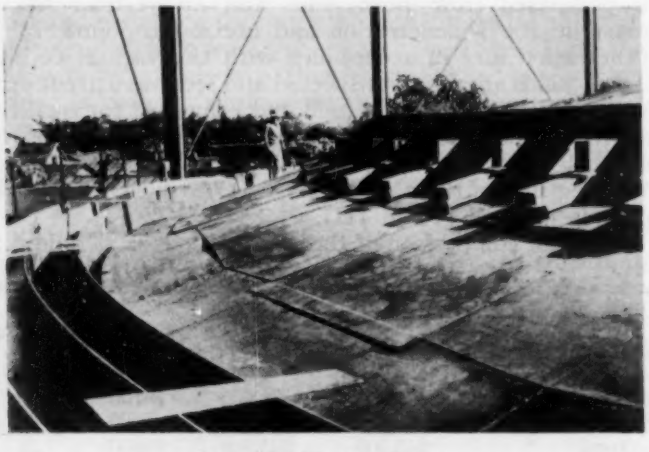


Plate VI—Welded Crown

Large, flat sheets do not have the inherent rigidity necessary for easy manipulation during erection nor the necessary strength to provide a rigid lift unless they have substantial thickness. For this reason, vertical strips of steel had to be riveted at intervals around the inside of old type lifts.

After consideration of the three problems, handling, shop work and rigidity, a bent panel was designed, consisting of a vertical sheet, measuring 84 in. x 30 ft. before bending. Each side is then bent to provide a flange 3 in. deep, having a further bend at the outer edge of about $1^1/_4$ in. (Fig. 6).

This flange provides a stiffness to the prefabricated element which, even with light gage steel, greatly facilitates handling. Moreover, the flanges of these panels, when bolted together, form about the interior circumference of the lift a plurality of reinforcements which give unusual firmness and rigidity to the lift, eliminating the need for stiffeners with a consequent saving of weight and freight.

Bolt holes are necessary for easy assembly before welding and are punched cheaply on a large automatic Thomas Spacing Machine at intervals of 1 ft. around the panel which is then flanged or bent on a large brake. Only 66 panels are needed to form an average lift for a 2,000,000-cu. ft. holder with a total of 4,620 bolt holes.

The savings to be obtained from using this welded panel construction instead of riveted plates are obvious when shop man hours are summed up as follows:

Riveted Plate Construction, 560 Plates, 3 x 8 Ft.		Welded Panel Construction, 66 Panels, 82 In. x 30 Ft.	
Punching	134 Man Hours	Punching	40 Man Hours
Grinding	45 Man Hours	Bending	18 Man Hours
Milling	192 Man Hours		
Scarfing	128 Man Hours		
Total	499 Man Hours		58 Man Hours
Rivet Holes, One Lift, 148,740		Bolt Holes, One Lift, 4620	

The Crown

The construction of the riveted crown was very expensive. Riveting required the men in the field to work from the inside as well as from the ouside. The shop operations for the fabrication of the riveted crown were also expensive; punching, milling, burring. The new

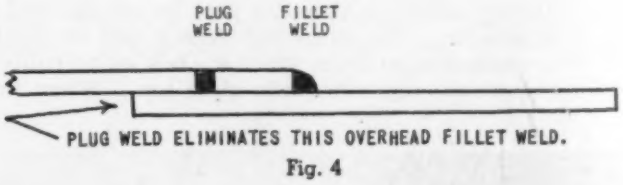


Fig. 4

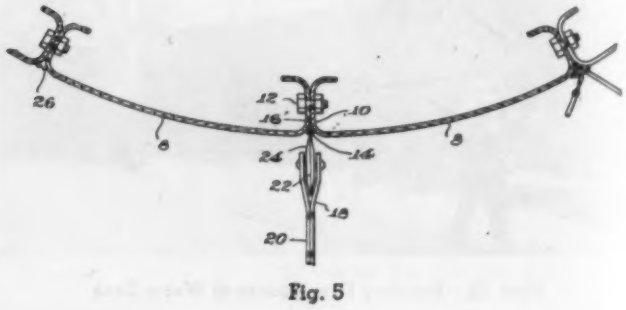


Fig. 5

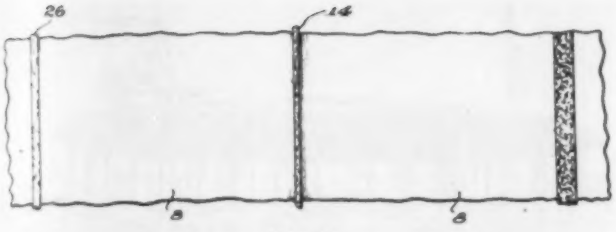


Fig. 6

welded design permits the cutting of plates to shape in the shop and punching only on one side and one end. The welded crown plates are then assembled on the permanent frame in the field with one edge and one end overlapping the adjacent crown plates (Plate VI). The holes on the two edges of the crown plates are then plug welded (Fig. 4) to the under adjacent crown plate and fillet welded around all edges for tightness. The use of the plug welds for these crown sheets, which are welded from the outside only, eliminates the necessity of expensive overhead welding of the under side of the crown. The crown is then progressively laid and made an integral part of the innermost lift. This is all accomplished by welding.

The comparison between the riveted and welded costs of the crown is as follows:

	Riveted	Welded	Saving	% Saving
Material	$6,500	$5,600	$900	14
Freight	1,800	1,600	200	11
Shop Labor	2,600	1,800	800	30
Field Labor	15,000	10,000	5000	33
Total	$25,900	$19,000	$6900	26

Erection of Lifts

Lifts are constructed starting with the assembly of cups on the bottom of the holder. The end joint of the cups is then completely welded and checked constantly to keep outer roundness to a very minimum. Due to the small amount of space between lifts they are erected starting with the outer and working consecutively to the innermost lift so that the surface to be welded is always open.

In erecting the lifts two or three bent panels are welded

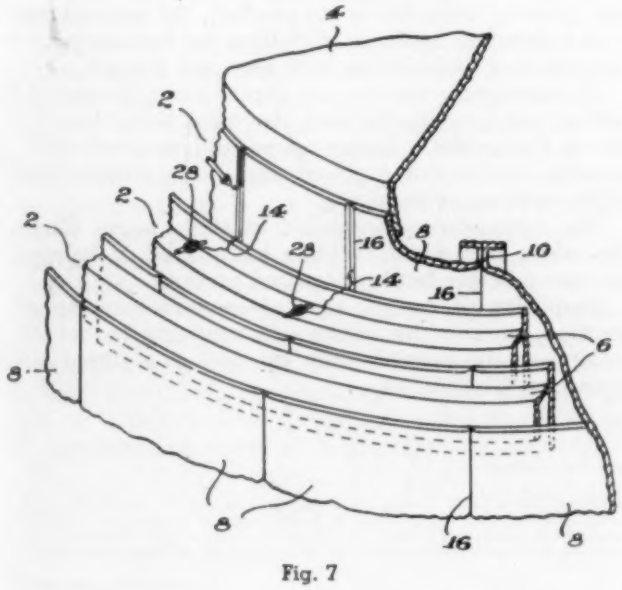


Fig. 7

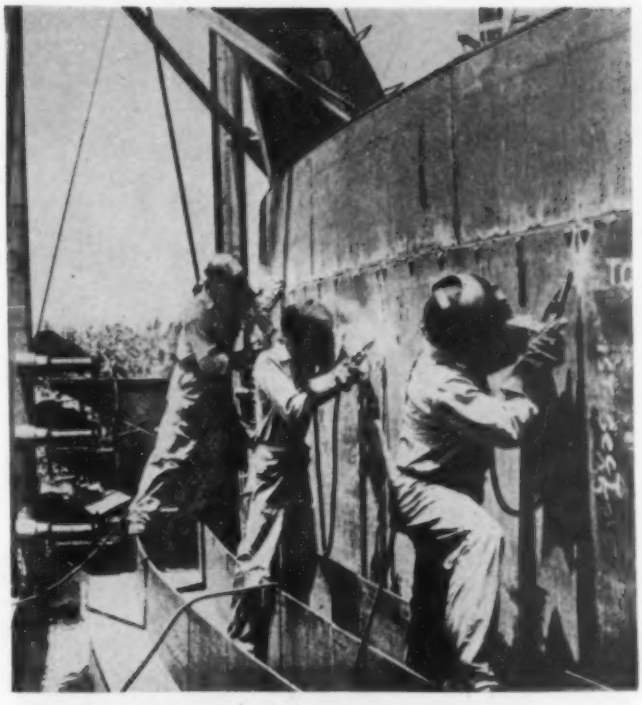


Plate VII—Welding Joints Between Panels on First or Innermost Section

together on the ground and lifted as a unit into position and bolted to their cup. Adjacent panel units are then bolted tightly into position and the joint between the panel and the cup is welded. It would be extremely difficult to weld the outside of the joint between panels at this stage of erection due to the lack of space. The obvious answer is to first assemble and weld the crown to the innermost lift, fill the water tank, and slowly raise the lifts by inflating them with air so the joints which

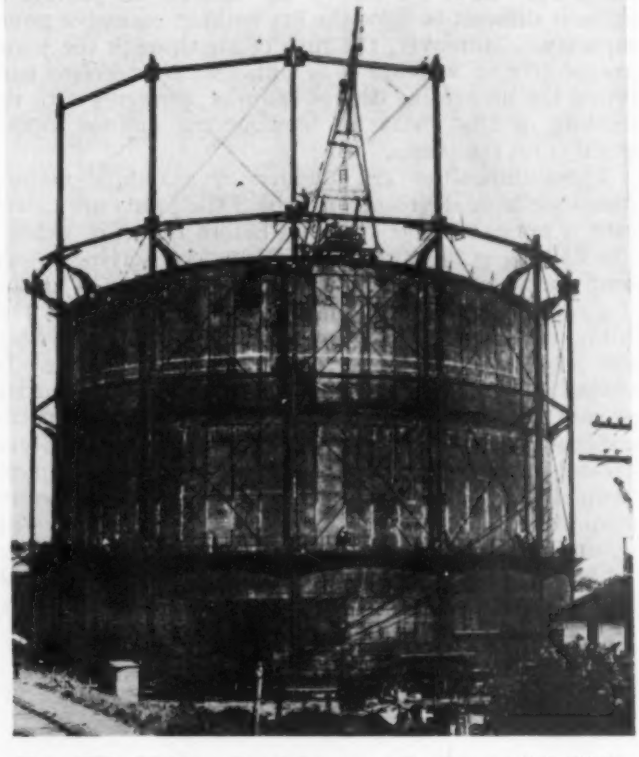


Plate VIII—Welding Panel Joints on the Second Lift While Constructing Guide Frame

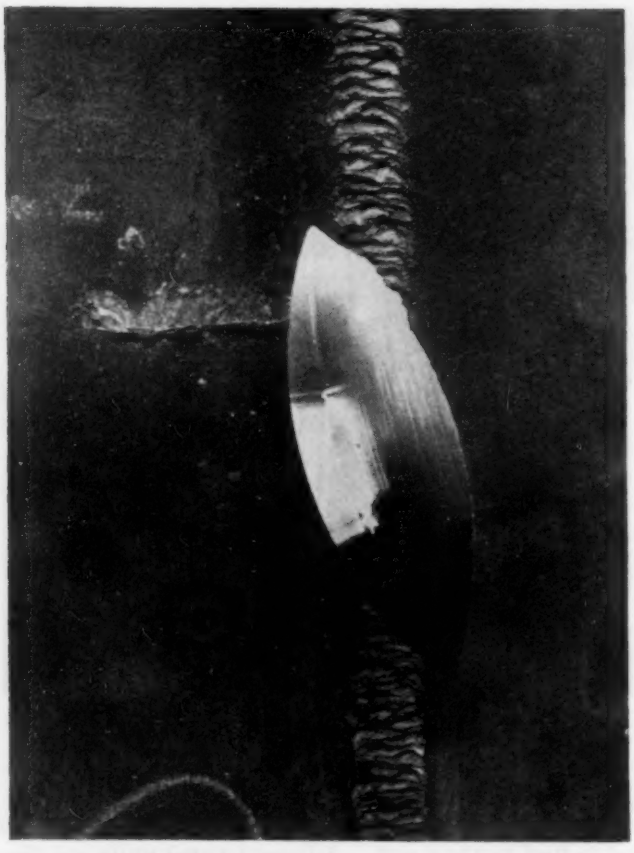


Plate IX—Testing Vertical Joint with Proper Machine

are to be welded slowly move past the welders who are able to stand on the coping of the tank (Plate VII). Very little air pressure is required to do this. Only the equivalent of ten or twelve inches of water will suffice if the joints between the panels are bolted sufficiently tight. When, however, the joints are not adequately tight the loss of air through the joint may make it difficult to raise the lift without excessive pump capacity. Moreover, the rush of air through the joints irrespective of whether it is sufficient to interfere with lifting the lifts in the desired manner interferes with the welding of the joints by blowing the molten welded metal from the joints.

These difficulties are avoided in a unique method which we have developed in which the joints are calked with a nonflammable material before they are welded. The calking is most suitably effected by forcing a soft, nonflammable yarn into the crack or crevice by means of a roller wheel device illustrated in the picture. This calking permits the lift to be raised to a higher elevation and consequently a greater length of the joint may be welded in a single operation. While in carrying out the process any suitable calking material which is nonflammable such as asbestos yarn may be used, it is of a special advantage to utilize a material which while being nonflammable is nevertheless combustible. This permits adequate sealing of the joints and maintaining the sealing during the welding and yet having the calking material burned out progressively while the joints are sealed.

For this purpose, it has been found that ordinary cotton rug yarn, flameproofed by impregnation with a fire retardent material such as ammonium sulphamate, ammonium phosphate, borax and other like well-known flame retarders, gives excellent performance. Thus, by this means of fabricating, calking is first placed in the crevices between the vertical panel then the crevice is welded, burning out the yarn, then more air is pumped into the lift causing it to rise and the new length of opening thus exposed is calked.

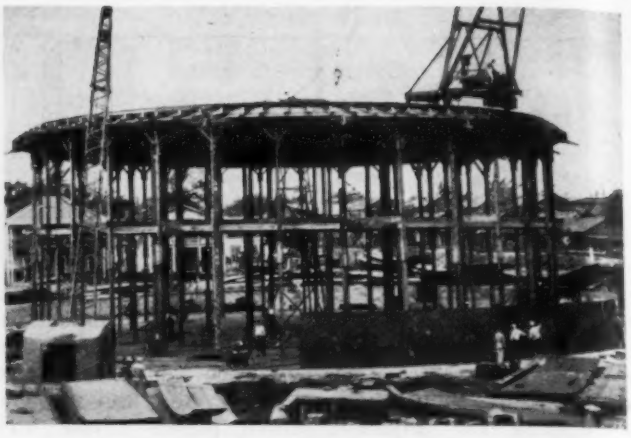


Plate X—View of Permanent Frame

Cost comparison of riveted and welded shell plating is as follows:

	Riveted	Welded	Saving	% Saving
Material	$12,000	$12,000	$ ..	....
Shop Labor	7,000	3,000	4000	57%
Freight	3,000	3,000	..	....
Field Labor & Misc.	10,000	7,500	2500	25%
Total	$32,000	$25,500	$6500	12%

Conclusion

The American public is constantly raising its standard of living through the ever-increasing purchase of those items which make life easier and more pleasant. Many of these items are operated by gas—gas stoves, gas furnaces, gas refrigerators, gas hot water heaters. To meet this growing demand for its product, the gas industry is now expending millions of dollars for replacement and expansion of its facilities, both here and abroad.

By constantly striving to improve our design of this needed equipment, Bartlett Hayward feels that it also serves the public. Lower priced and more efficient apparatus means lower priced and more efficient public utility service for humanity.

The comparisons presented in these pages illustrate the major role which welding has played in helping us produce a better but lower priced product.

Simplicity of design, ease of manufacture, speed of erection, greater durability—all resulting in benefit to society—made possible only by, and as a direct consequence of, *Welding*.

Creative Architectural Design with Welded Rigid Frames*

From Studies of Living Structures

By Martin P. Korn†

IN SEPTEMBER 1939, the Association of Collegiate Schools of Architecture assembled at Washington, D. C., at their national meeting. Before that distinguished group there passed in review Design of Today and Tomorrow. The influence of the great pioneer architect Louis Sullivan, of the imaginative Hugh Ferris and of the creative Saarinen had already left their imprint on contemporary design in vertical architecture as exemplified in our towering skyscrapers. But by this time there was already becoming manifest new functional horizontal architecture, low, long and horizontal structures of singular beauty under the influence of creative designers like Gropius, Aalto, Van der Rohe and le Corbusier.

Most challenging, however, in horizontal form was a comparatively unknown school of design of welded steel rigid frames that began to appear here and there stretching out their power in undulating shafts of extended rhythm. What did that mode of functional steel ribs portend, holding sway in single leaps where we were accustomed to see trusses zigzagged aloft?

With a view to learning the effect welding might have on the future of architecture, the late E. W. P. Smith, Consulting Engineer, Lincoln Electric Co., Cleveland, was invited to address the above convention. In a provocative lecture of absorbing interest, Ed. Smith showed the way to new creative architectural form with welded rigid frames. His memory will remain enshrined in the knowledge which he left to the future by that lecture and by others. This lecture is intended to carry on where he left off in 1939.

The advent of the war skyrocketed the welding process to almost universal demand and use because of sheer necessity. Steel became war's mighty weapon, speed in production the first requirement, strength in that steel as essential as the lives it meant to save. Welding was the process that proved most efficacious to that end. Its accomplishments are now history crammed with record-breaking precedents in quantity, quality and efficacy.

Bailey bridges consisting of prefabricated and identical welded units fabricated in various shops here and in England were concentrated in dumps, selected without regard to their origin, pinned together for short spans, set in vertical layers for long spans and presto, like magic toys they functioned immediately to carry fully loaded trains of material over rivers and ravines. Precision without precedent, speed without precedent, strength for rugged use—thus read the record. Welding made that record possible. Without welding our war record could not have been made.

While costs were not of prime consideration, economies followed naturally in the wake of speed through welding. Our Navy Department, generally conservative, reached out boldly, threw aside tradition, changed from riveted to all-welded caissons of floating dry docks, saved 33% in weight of steel, reduced time of fabrication one-third, and to quote their report "paradoxically made for added strength and stability." It sounds almost magical. It is cold fact.

These are some tidbits picked at random from endless testimony as to the strength of welds and their efficacy. Because of that strength, speed and economy, welding became the dominating process for uniting metals during the war.

That process is now yours with unlimited possibilities for creative architectural design with gentle curves or daring thrusts.

The Rigid Frame

Take your pencil, sketch a simple straight beam, bend it, strengthen the bend properly and there you will have the elementary rigid frame. Two operations made it a rigid frame—the change in direction of its neutral axis and the addition of sufficient strengthening material at the bend to preserve its hegemony of internal resistance through continuity. If that bend consist of a sweeping curve without rivets, your sketch will represent the elementary welded rigid frame.

Add two more bends with legs turned downward, widen those bends, and you will have another type of welded rigid frame. It now has a complete form applicable to a building.

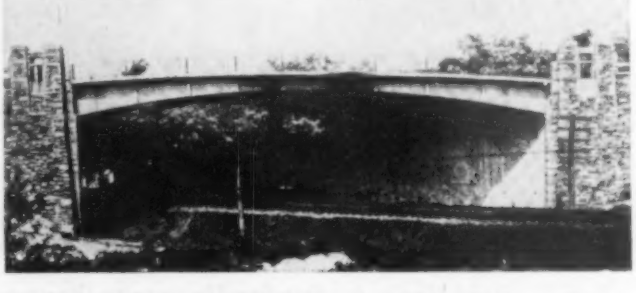


Fig. 1—Rigid Frame Bridge Carrying Bronx Parkway Extension Over New York Central Railroad at Mt. Pleasant, N. Y.

* EDITOR'S NOTE: This monograph is an extract from notes for lecture delivered by the author at the College of Architecture and Design, University of Michigan, Ann Arbor, on April 14, 1948. The notes were supplemented by slides, illustrations and creative designs other than those published here.

† Consulting Engineer.

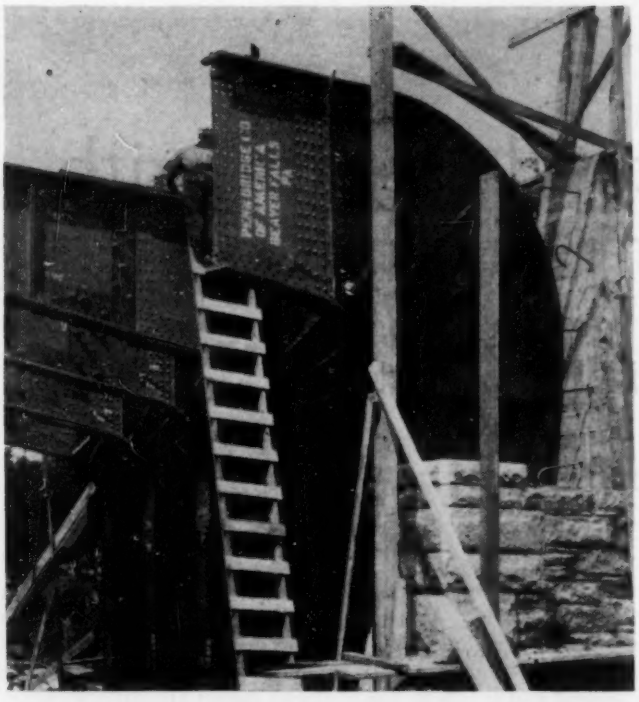


Fig. 1 (*A*)—Close-up View of Knees in Fig. 1 Before Encasement in Masonry

Try a few more bends outward at will along functional paths or in fanciful design, as for example a theme building (or accent motif) for an exposition group, completing the two basic operations at each bend, and see what you can see?

You have now moved out into space in a two-step or waltz rhythm of functional design or perhaps in a rhumba of architectural fancy with knees bent, sudden dips and swings which you had never previously attempted. Or perhaps your creative rendering has developed in a key suitable to a certain client after the Stoics—a few sharp bends, several cold thrusts, a downward plunge, deep anchorage in the earth. Is it really possible to build as projected a symphony in steel with rigid frames?

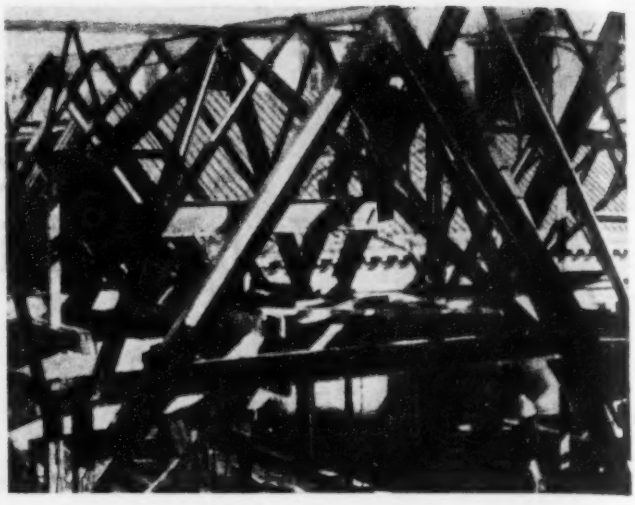


Fig. 2—All-Welded Yale Dormitories Built in 1931. (View Shown Is Similar to the Elementary Welded Rigid Frame in the First Rendering)

Since we are now exploring the possibilities of creative architectural steel design, let us first turn and face reality in the living structure.

Reality

The rigid frame is a structural "tour de force" executed for economy or functional form or for both purposes. This is true whether it is constructed of concrete, steel or wood. Esthetic form is a natural accompaniment because of the stress behavior pattern, highest stress at knee and lower at crown, permitting a sweeping curve for economy.

Concrete rigid frames came first, followed by riveted steel types. Both types borrowed the arch form, gave it legs, unveiling at grade crossings structures of economy and new functional design. Welded steel rigid frames came later. Whereas the title of this lecture features

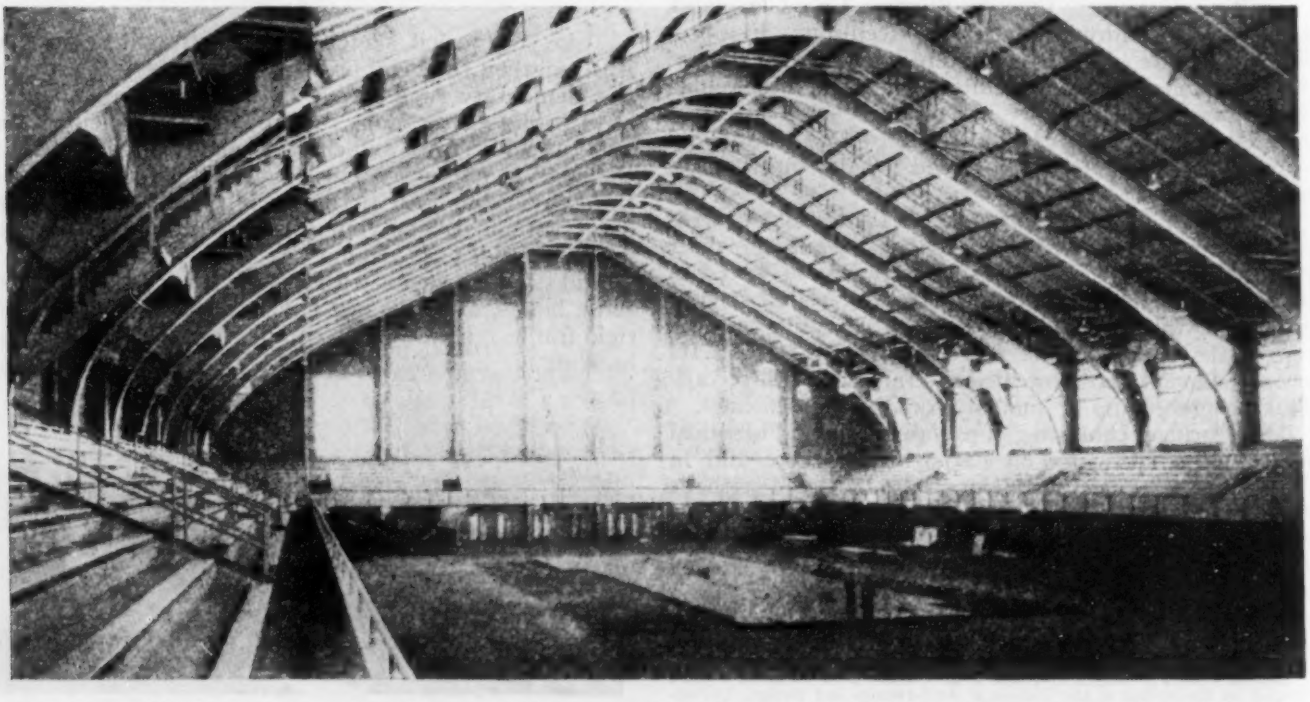


Fig. 3—Field House for Purdue University (Representing Type of Rigid Frame Design Developed by the American Bridge Co.)

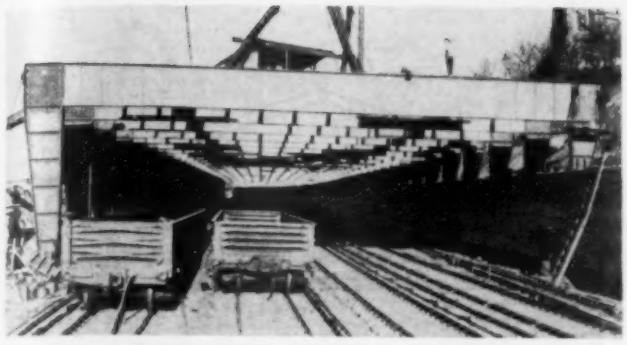


Fig. 4—Rigid Frame Subway for New York Central Railroad, West Side Improvement, New York City. Designed by Madigan-Hyland, Consulting Engineers, New York

welded rigid frames, your education would be biased, it would not be complete if I proceeded by ignoring the riveted types. There is no denying the age of outstanding structural accomplishments with the riveting process. Towering structures stand testimony to their time-proved strength. Besides, there are still many persons prejudiced against welding and you might be one of them Accordingly, both types of structures will be examined from studies of living structures. These studies will serve for discussion based on fact rather than opinion. Comments will follow translating those facts, accompanied by brief historical notes.

Figure 1 presents a steel rigid frame bridge, one of many built by the Westchester County Parkway System in New York State in the twenties. Planned for esthetic form and economy, it had other advantages. It permitted saving in headroom below the structure and required a lower depth at crown than would have been necessary with simple girder design. Note sweep of the lower chord curve which closely follows the stress behavior pattern. Figure 1 (A) is a close-up view of the riveted knees before they were encased in masonry.

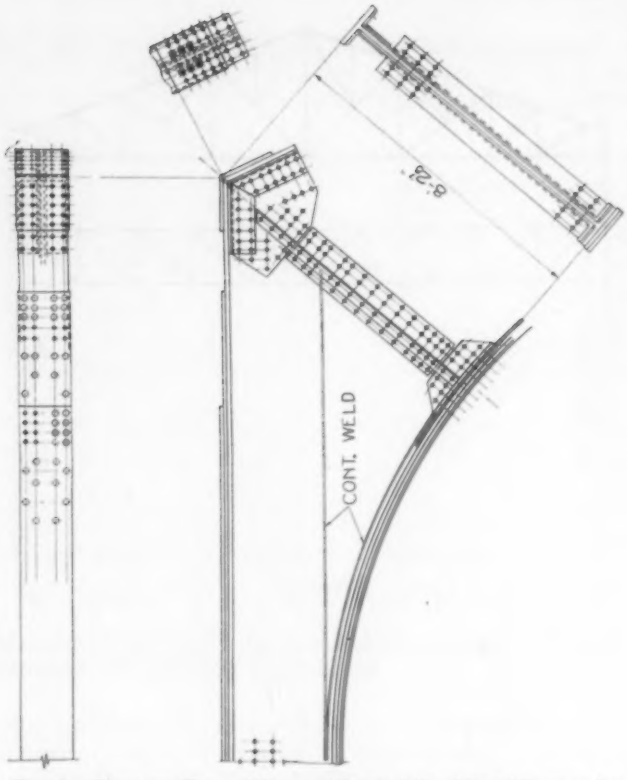


Fig. 6—Close-up View of Knee of Riveted Steel Rigid Frames for Field House Built in 1939

The Westchester County Parkway system was among the first to employ rigid frame construction while at the same time exploiting to the full its natural esthetic advantages. The above structure won the first prize in esthetic steel design for 1929 awarded by the American Institute of Steel Construction. (Reproduced from *The Rigid Frame Bridge* by Hayden by permission of John Wiley & Sons.) Arthur G. Hayden, Designing Engineer, in charge of that program of rigid frame bridges had vision and courage in addition to outstanding ability. He would have welded some of those bridges if permitted—and that was more than twenty years ago.

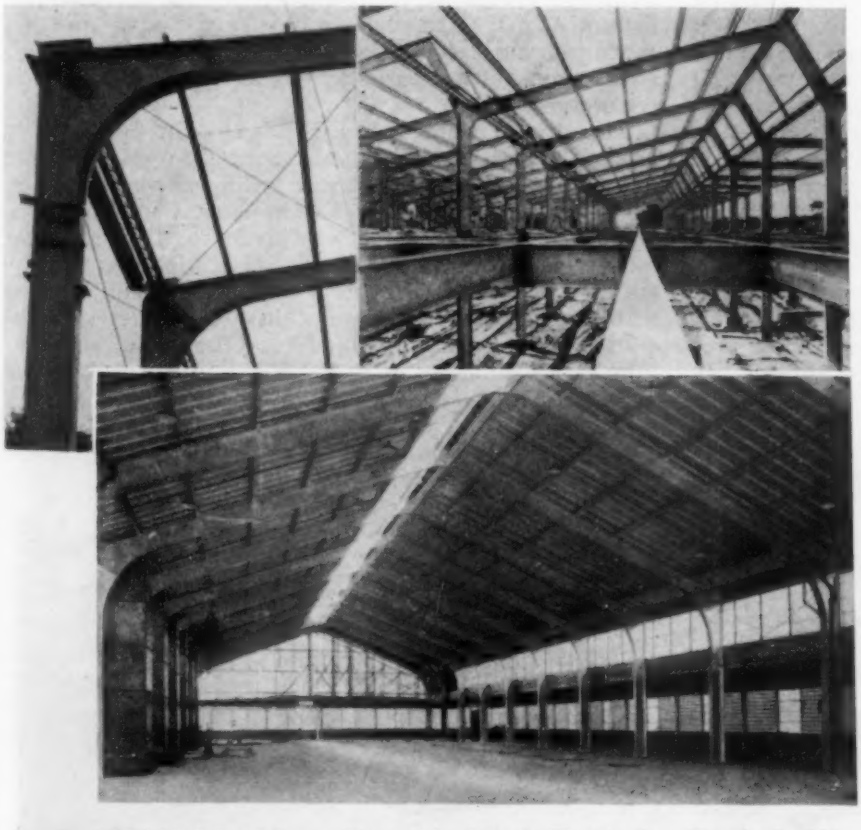


Fig. 5—All-Welded Rigid Frame Plant of the Lincoln Electric Co., Cleveland, Ohio. Full Rigid Frame Spans in Lower View; Close-up View of Knee, Upper Left; Saw-Tooth Frames, Upper Right

Figure 2 presents one of a group of Yale dormitories built of all-welded steel construction in 1931. The roof framing is similar in form to the simple type of welded rigid frame in your first rendering herewith. Many complicated steel connections were reduced to the simplest form by the employment of welding under Elwyne E. Seelye, Consulting Engineer. (Reproduced from *Arc-Welded Steel Frame Structures* by Gilbert D. Fish by permission of McGraw-Hill Book Co.)

Prior to this and during the twenties, welding emerged from the laboratories for use in the construction of a number of smaller buildings. It was during that period that welding "came of age" through construction fostered by manufacturers of welding equipment and a few pioneering engineers among whom was Gilbert D. Fish, well known for his welded design of the Air Terminal at Grand Central Station in New York.

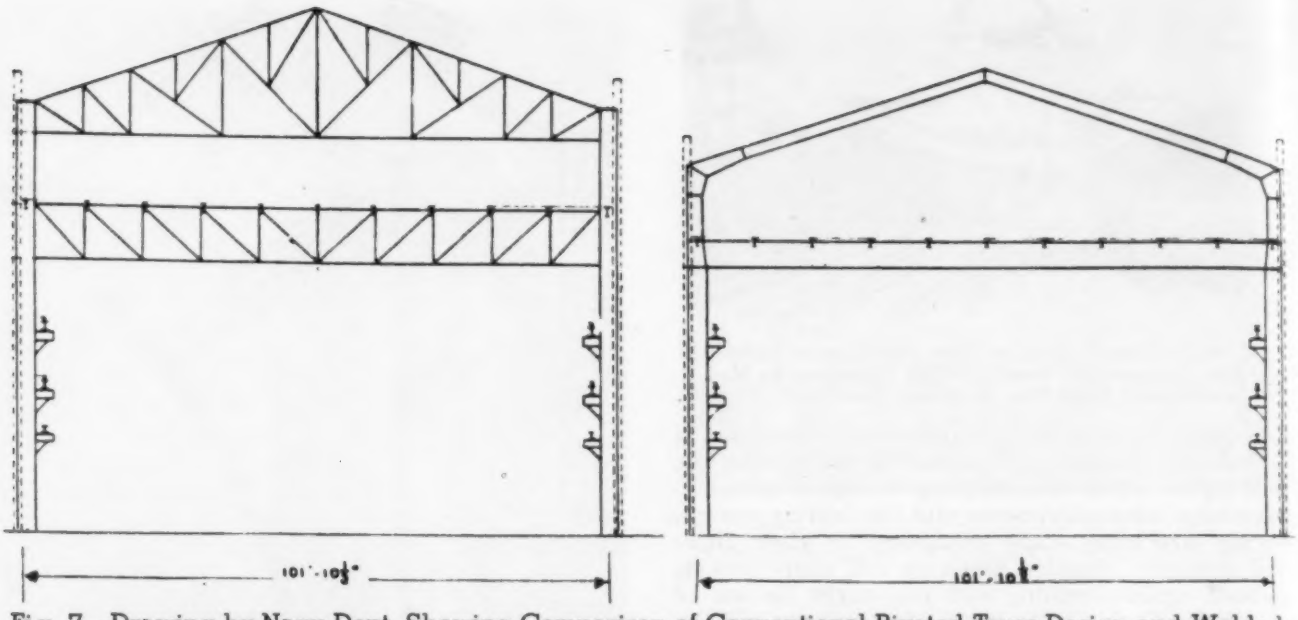


Fig. 7—Drawing by Navy Dept. Showing Comparison of Conventional Riveted Truss Design and Welded Rigid Frame Design for Structural Shop, Navy Yard, Boston, Mass.

Figure 3 presents a type of riveted rigid frame for field houses and auditoriums developed by the American Bridge Co., in the early thirties. To quote their own statement, "it eliminated interior columns, deep trusses, unsightly networks of small members and bracing systems, afforded a minimum obstruction to light, ventilation and vision without any material increase in cost."

All of those advantages apply equally to welded rigid frames as we will soon learn.

Construction of those steel rigid frames in the early thirties by the American Bridge Company and others at once paved the way for architecture to uncover building steel to artistic view. Every effort in the past made for concealment of the sprawling steel skeleton wherever practicable aside from fireproofing purposes for trusses in buildings could never make any pretense at beauty.

Figure 4 presents a view of a riveted rigid frame subway built in 1936 for the New York Central Railroad in the West Side Improvement in New York City. Planned primarily for economy over its adjoining section in which through girders were used on masonry walls, its architectural line cannot be denied. $1,200,000 was saved by use of the rigid frame design.

Note the straight top and bottom chords and the right angle knees, a variation from the curved knees and main spans previously studied. Other variations will be presented as we proceed. You will thus become familiar with their versatility, distinct advantages aside from their economy.

Figure 5 represents the all-welded rigid frame plant of the Lincoln Electric Co., Cleveland, Ohio, designed and constructed by the Austin Co., architectural pioneers in functional welded steel design. Note the artistic form of the loft and the saw-tooth frames, resembling in some degree the "dips" in your rendering as you began these studies. Observe also that natural simplicity of the knees, a characteristic made possible only by welded construction.

Similar types of welded rigid frame design for industrial buildings were brought forth early by the architectural firm of Albert Kahn of Detroit. Their "dips" for saw-tooth framing were shop-welded and esthetic in appearance. Some of their early designs used rivets for the field connections.

Thus in the thirties courage abetted by creative art integrated with structural design made for wider exploitation of new functional form with welding, serving at once as a challenge to the future in horizontal steel building design. Further impetus was given to that trend by full-size tests of both welded and riveted rigid frames conducted by the U. S. Bureau of Standards in conjunction with the American Institute of Steel Construction. To quote from a research pamphlet published by the U. S. Bureau of Commerce in 1938, "The fundamental reason

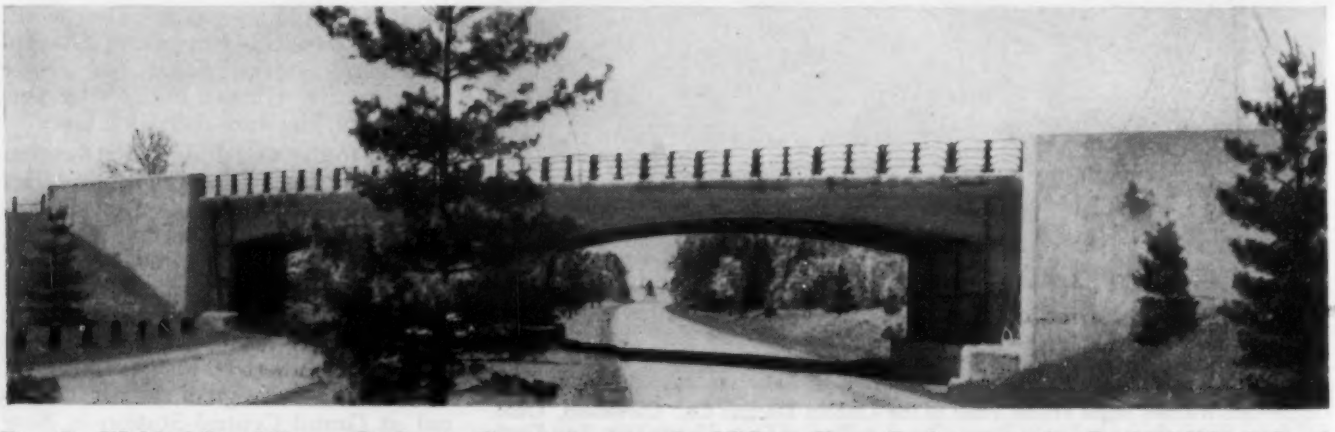


Fig. 8—Welded Rigid Frame Bridge in Connecticut on the Wilber Cross Parkway at the Derby-Milford Road

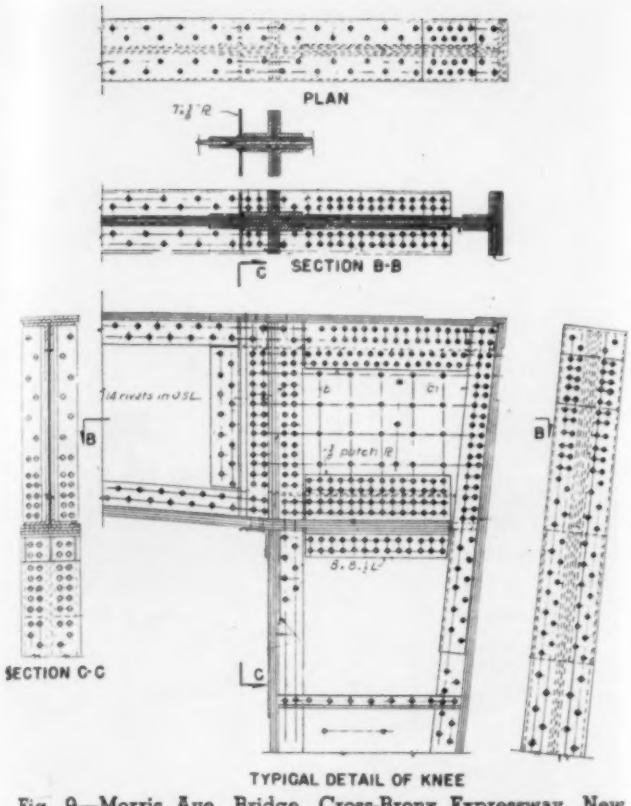


Fig. 9—Morris Ave. Bridge, Cross-Bronx Expressway, New York State Project

for the increasing use of rigid frames is their economy . . . ease of maintenance and other advantages." There you have another cold statement of facts previously indicated for other structures.

Architecture was now fortified to plan new functional form with riveted or welded steel rigid frame design in the light and experience of structures already built. Welded frames were obviously more esthetic and functional. But the welded joint was still a mere infant in age compared with the riveted joint. Since confidence in the welded joint and its strength had not fully matured in the late thirties, there evolved as a result a "hybrid" type of combined riveted and welded rigid frame which we will presently consider.

Figure 6 presents a close-up view of a knee in a riveted steel rigid frame for a field house built in 1939. It poses a question for academic discussion and comparison with all-welded knees. Observe the mass of field rivets required to make the joint in the knee. Not shown are additional rivets in quantity on the bottom flange of the curve. Observe also the mass of reinforcing plates required. What is the necessity for these massed formations of additional splice and reinforcing plates and the hundreds of rivets around that joint? The answer is simple. There must be continuity in that joint to make it a rigid frame and with rivets there is nothing else you can do to obtain that continuity.

Let us return to the fundamental principles we have already discussed.

A rigid frame is a monolithic structure typifying all-continuity.

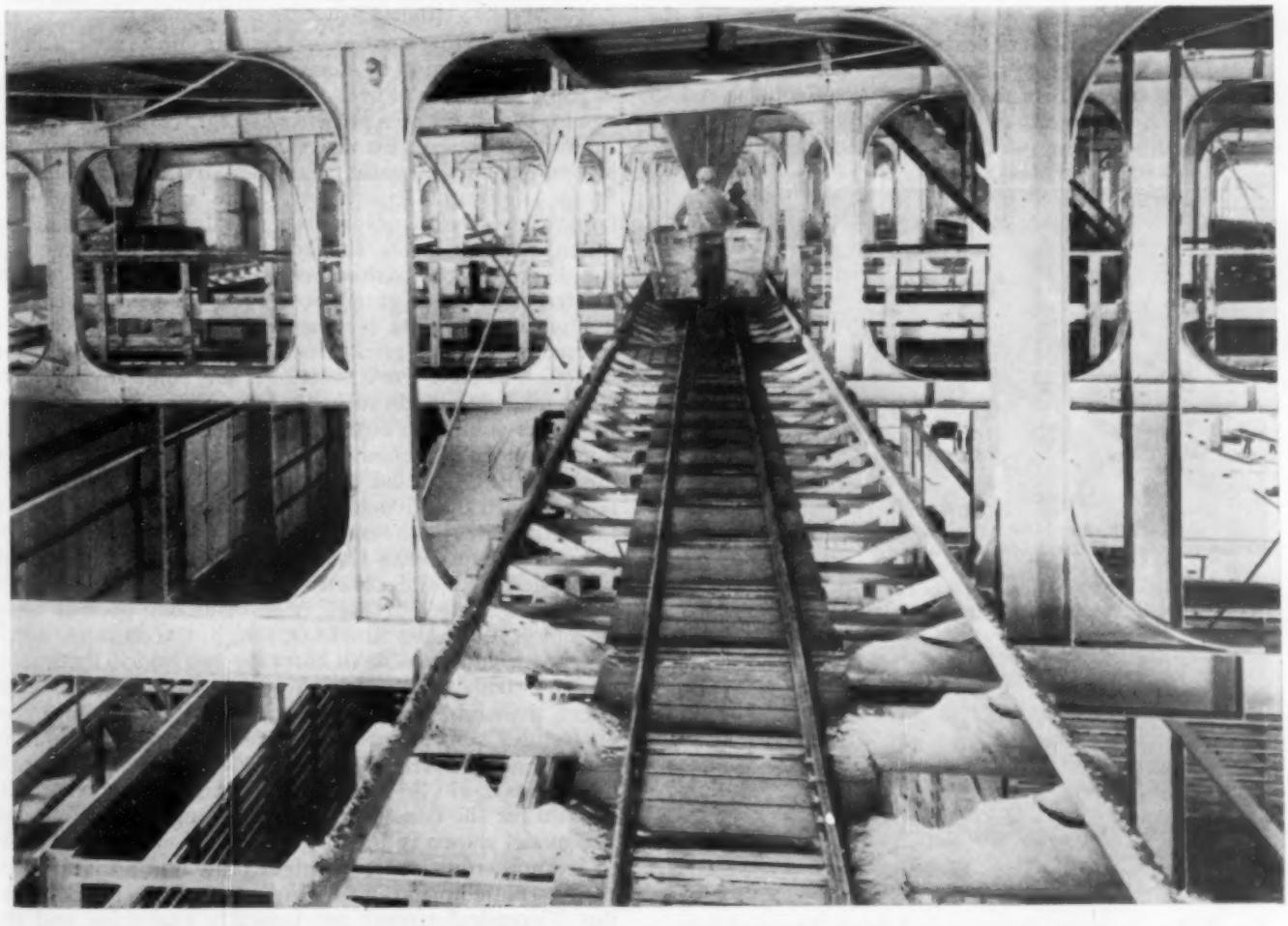


Fig. 10—All-Welded Vierendeel Trusses at the International Agricultural Chemical Co. Plant, Chicago, Ill.

No riveted steel rigid frame can develop continuity without massed formations of additional splice and reinforcing plates and regiments of rivets at its joints as observed here.

Welding is synonymous with continuity—its very process of fusion makes for natural continuity. This is the crux of the difference between the riveted and the welded rigid frame. You have already examined both types of design and it is hardly necessary to point out the naturalness and simplicity of the welded type. These factors we are taught are basic to functional architecture. But if you are afraid of welding and select the riveted type, you must be prepared to sacrifice those basic characteristics for functional design. You must also be prepared for a similar massing of material and defensive rivets in close formation as above in the knee joint. The fact is that a joint anywhere in a riveted design will require similar fortifications in steel. You cannot avoid them.

We might now pause before planning an all-welded design in fear that its joints cannot be assured the strength of rivets. Let us examine this structure further. Have you noticed anything unusual in the web plate of this knee? Passing right through its vital points of stress are simple, unobtrusive and unfortified welded joints which must perforce function 100% for safety. Dare any one question the strength of those welded joints? They are very much alive today beside their riveted partners and doing just as much work. The fact is that welding sneaked into that joint quietly because there is no other way of fabricating a rounded riveted knee for a large frame.

Figure 7 presents a welded rigid frame design of a structural shop executed by the Navy Department in 1939. (Reproduced from THE WELDING JOURNAL, Jan. 1940.) Beside it is a conventional riveted design made by the Navy for a comparison of costs. The welded rigid frame design was $14,000 lower in cost and it had other advantages. To quote from their report "it effected a reduction in the height of the entire building of 9 ft. 6 in. and a corresponding saving of future maintenance and heating." That statement of fact requires no comment other than the suggestion to store it for future reference.

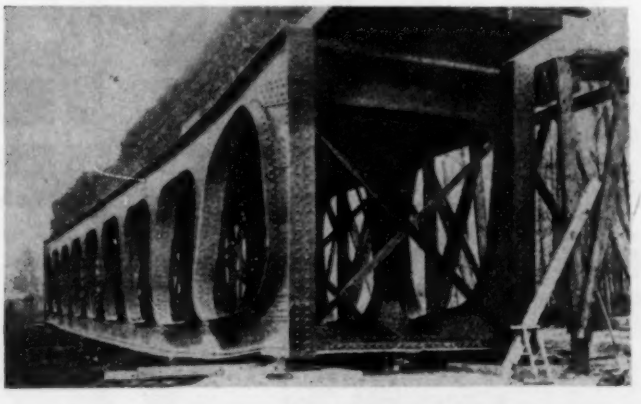


Fig. 10 (*A*)—Official Photograph of the First Vierendeel Truss Bridge Built and Tested to Failure in 1897 in Belgium

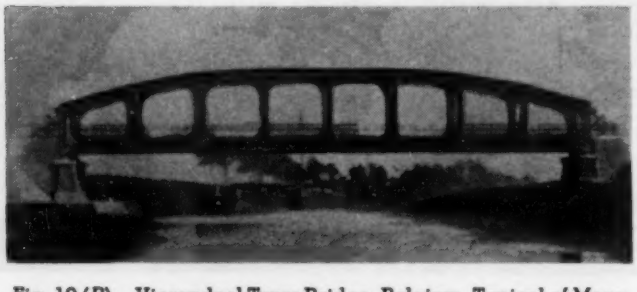


Fig. 10 (*B*)—Vierendeel Truss Bridge, Belgium, Typical of Many Built During Lifetime of Prof. Vierendeel

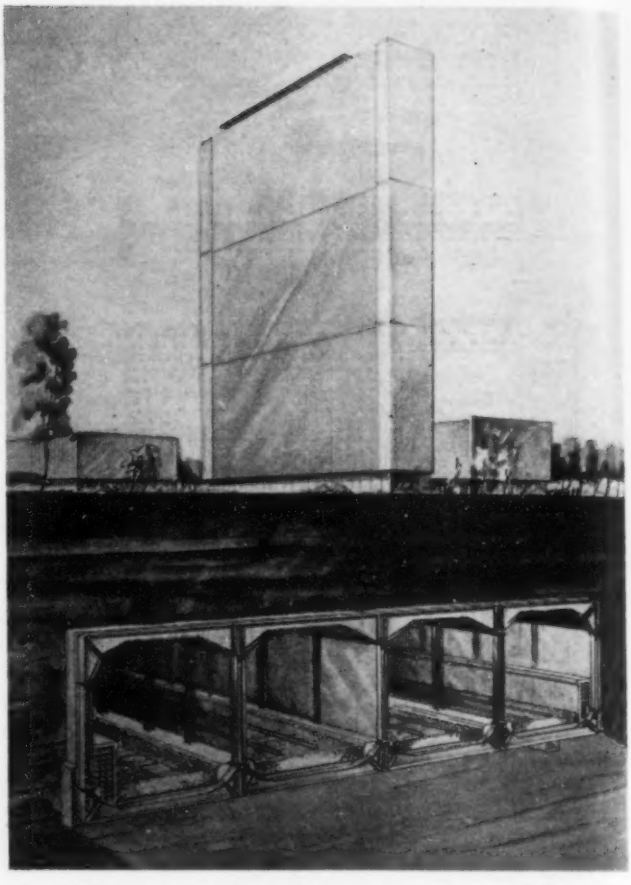


Fig. 11—Architect's Rendering of Proposed All-Welded Rigid Frame Design for the Second Avenue Subway, New York City (United Nations in Background)

Note the angular knees as compared with the round and square types of knees presented so far.

Figure 8 presents an all-welded rigid frame grade crossing constructed several years ago by the Connecticut State Highway Department. The view is that of a monolithic steel structure as natural as though made in a single mold. Note the knees and their architectural simplicity for comparison with that of a similar type of riveted rigid frame grade crossing in the next study.

Figure 9 presents a close-up view of the knee of a riveted rigid frame grade crossing projected for early construction in New York State. It has single spans somewhat longer than those in the preceding study. Otherwise it is similar in outline. Its design is excellent and hardly any improvement is possible for its type of riveted design. But from an architectural viewpoint, by comparison with the all-welded knee in Study No. 8, the close formations of rivets resemble a shell-pocked area.

Figure 10 presents the interior view of an industrial plant designed and constructed by the Austin Co., in which Vierendeel trusses (rigid frames) proved most suitable. Carrying tracks through the trusses, loads overhead, and capable of carrying suspended loads, this design is truly functional. Without striving for esthetic effect, the simplicity of the monolithic joints at once take on natural beauty. How different in appearance from the original riveted design conceived by Prof. Vierendeel fifty years ago! So convinced was he of its efficacy that he paid for the construction and testing of the first full-size model shown in Fig. 10 (A). Prof. Vierendeel lived to see numerous riveted bridges built and acclaimed for their esthetic appearance. Figure 10 (B) is an example. But Vierendeel trusses are basically expensive and the riveted designs of this day remain almost like the original

Fig. 12—2,000,000 Gal. Water Tank, Washington, D. C. (Photo by Delmer L. Curtis Aerial Photo Service, Tulsa, Okla.)

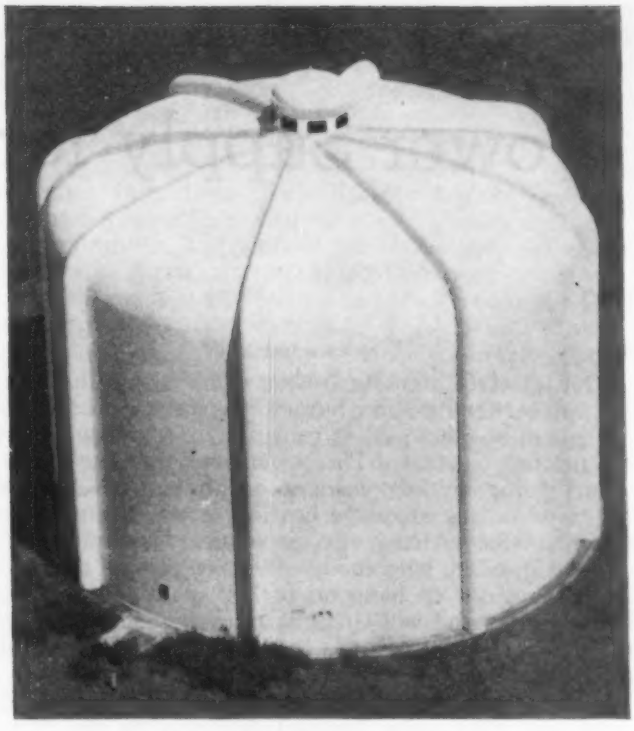


Fig. 13—2,500,000 Gal. Standpipe, Tulsa, Okla.

prototype, studded with myriads of rivets and splice materials. Welding eliminates the fortifications of excess metals and the rivets that they make necessary.

Figure 11 presents an architect's sketch of an all-welded type of rigid frame subway proposed for the new Second Avenue line in New York City instead of the conventional riveted type of articulated bents. Conceived with the idea of mass production of identical units, its construction will effect vast savings aggregating thousands of tons of steel and many millions of dollars in costs. It is presented here only to indicate what savings the future holds in store for welded rigid frame design in horizontal form.

Yesterday Resigns for Today

Selected studies of living and projected rigid frame structures have now passed in academic review, reflecting a generation of performance upon which architecture can safely pass judgment for their own planning. The choice of riveted or welded construction, if not warped by preconceptions, can definitely be based upon fact. I, for one, can look back with reverence upon riveted structures I designed forty years ago which still stand as sentinels of strength, and to many others which I designed throughout those intervening years. The advantages of riveted design over welded design have thus been recognized for certain types of construction and under certain conditions. It is only in a spirit of progress, Yesterday resigning in favor of Today that welded rigid frames are presented herewith as a more advanced and more fundamental basis for creative horizontal design. As evidence of its possibilities let us move forward for a brief preview of Design of Tomorrow in terms of Today.

Creative Design

Throughout the ages there has been a close relationship between painting and architecture. Both arts had their baroque periods. Present day interest concentrates on good clean design and the most effective use of materials. To modern painters, "architectonic" is an adjective in great favor. Conversely painting has influenced architecture. The compositions of the painter Mondrian have their exact counterpart in Mies Van der Rohe's Metallurgical Research Building at the Armour Research Foundation, Chicago.

Welding has liberated steel from its old limitations to such a great extent that it is now possible to make almost any kind of design. We could reproduce the angles of Picasso, we could experiment with steel as the painters did with paint. But whereas the painters can be escapist or bizarre occasionally, the architect must first of all consider function.

Suggestive of a surrealist symbol by Dali is an all-welded steel creation by the Chicago Bridge & Iron Co., Fig. 12. Actually a water tank designed to harmonize architecturally in a select environment in Washington, D. C., it appears as a figure conceived in "the mind's eternal heaven where dreams are begot." Its singular esthetic form was made possible only by welding.

Figure 13, majestic in its apparent isolation, at once stands out as a challenge to the imagination. That, too, is a water tank.

Let us now return to the beginning of this lecture and your creative renderings, some of which were functional and others fanciful. We have just observed variations in horizontal steel design that were without precedent in structural form prior to this new age of welding. Reality as manifested in living structures revealed possibilities which we could only imagine before we began these studies. Natural in form as though cast in a single mold, vertical shafts of steel joined up with others shaped to individual needs and purposes to hurdle over space in single leaps—monolithic frames seemingly without end. Do your creative renderings seem more possible now? These living structures of today stand testimony to your unlimited possibilities for a New World of Tomorrow with Welded Rigid Frames.

Power Supply for Inert-Arc Welding*

By A. U. Welch†

INERT-ARC welding (fusion of metal by an electric arc between it and a refractory electrode in an atmosphere of inert gas) is generally accomplished with alternating current. Direct current of the proper polarity for fluxless welding of aluminum—electrode positive—causes excessive heating of the electrode and uncontrollable melting, also mechanical instability of the arc. A d.-c. arc long enough for easy manual operation has a tendency to hang on to hot spots on the metal being welded and will either skip or wander as the electrode progresses along the seam, but the a.-c. arc will follow steadily the motion of the electrode.

As a.-c. inert-arc welding requires special power equipment and may cause unusual demands on the power supply circuits, an investigation of these demands seems in order.

The usual a.-c. arc-welding transformer will not successfully operate an inert-arc as the open circuit or restriking voltage required to start current flow for the half cycles when the work is negative is far above that of the transformer. Arc welders generally have open circuit voltages on the order of 75 v. rms. but approximately 200 v. are required for consistent stability of an arc in argon and much higher voltages are required in helium. Not much voltage is required to start emission of electrons from a tungsten electrode, therefore a low voltage welder will permit only alternate half cycles of current to flow, in other words the arc will act as a rectifier. Fluxless welding cannot be accomplished this way because the half cycles of work negative are the ones during which the oxide films on the metal are dispersed so that the molten metal can flow together to make a weld. The use of high 60-cycle voltage is impracticable for the reason of shock hazard, cost and high kilovolt-ampere demand.

Two quite different equipment designs have been developed to permit inert-arc welding with moderate power voltage. One widely used method is the addition of a high-frequency pilot to a welder of usual voltage. The pilot superposes on the 60-cycle power a high voltage at frequent intervals, usually many times in each half cycle of 60-cycle current. By this means the work-negative half cycles can be started each time and fluxless welding is possible.

Because of the high voltage needed for reliable impulse starting, several hundred to several thousand volts, considerations of operator safety require that the frequency of the pilot voltage be high enough so that skin effect protects the operator from shock. Frequencies on the order of 100 kc. to 2 mc. are generally used. Unfortunately, the high voltage at these frequencies causes considerable radio noise to be radiated from the welding lead. It is possible to shield the generating equipment but the leads required for welding cannot be shielded and even a few feet of lead make an excellent antenna. Complete shielding such as placing the entire equipment and work in a metal clad room and filtering all incoming power lines is usually too expensive. In some applications metal frame buildings have provided sufficient shielding to avoid serious interference with radio communications. However, there have already been many instances where radio interference from high-frequency pilots has caused shutdown of welding equipments in the short time—2 years—that this type of welding has become widespread. The rules of the Federal Communications Commission set limits on radiated field strength at all frequencies above 10,000 cycles, and these limits are lower than the radiation that can be expected from a high-frequency pilot circuit with power adequate for proper stabilizing of an inert-arc supplied by a low-voltage 60-cycle transformer. The frequency bands assigned for industrial heating equipment, 13.66, 27.32, 40.98 and 2450 megacycles are not suitable for high-frequency pilots. The capacitance current to the operators hand and corona, caused by capacitance current between cables and ground, are excessive. Also it is probable that the modulating effect of the spark discharge through the welding arc would cause harmonic radiations above the specified limits.

Turning to the low-frequency part of the circuit additional problems are encountered. Contrasting with the usual welding arc in which the electrode and the metal being welded have similar characteristics, the tungsten electrode used in inert-arc welding operates very much hotter than the molten metal being welded and emits electrons much more readily. This results in a d.-c. component of current. The d.-c. voltage component is a function of electrode size and temperature, arc length and gas used and is generally in the range of 4 to 12 v. The direct component of current is subject to variation depending upon the equipment used, being equal to the voltage divided by the d.-c. resistance of the welding circuit. Length and size of welding lead used will affect d.-c. component substantially as the resistance of the small water-cooled cable used with most inert-arc electrode holders is large. Also the rating and design of the welding transformer will affect it. Tests on typical equipments show d.-c. component ranging from 40 to 70% of total rms. secondary current, with 50% as the most usual. The d.-c. component is so large as to cause serious problems in addition to the nuisance problem of forcing the use of a large direct reading a.-c. ammeter to measure current because a current transformer is useless in such a circuit.

The oscillograms of Fig. 1 show typical current and arc voltage wave shapes. The flat-topped portion of the arc voltage occurs when the work is negative, and is a much higher voltage than the other half cycle but is of much shorter duration. The large d.-c. component of current is obvious in the oscillogram; d.-c. equals 55% of total rms. current. Figure 2 shows two parts of oscillograms of primary and secondary current, the first taken immediately after starting, the second, one and one-half seconds later. Here may be seen one of the most troublesome problems arising from the d.-c. component. This component slowly saturates the transformer core requir-

* Conference paper presented at the A.I.E.E. Winter General Meeting, Jan. 29, 1948.

† General Electric Co., Holyoke, Mass.

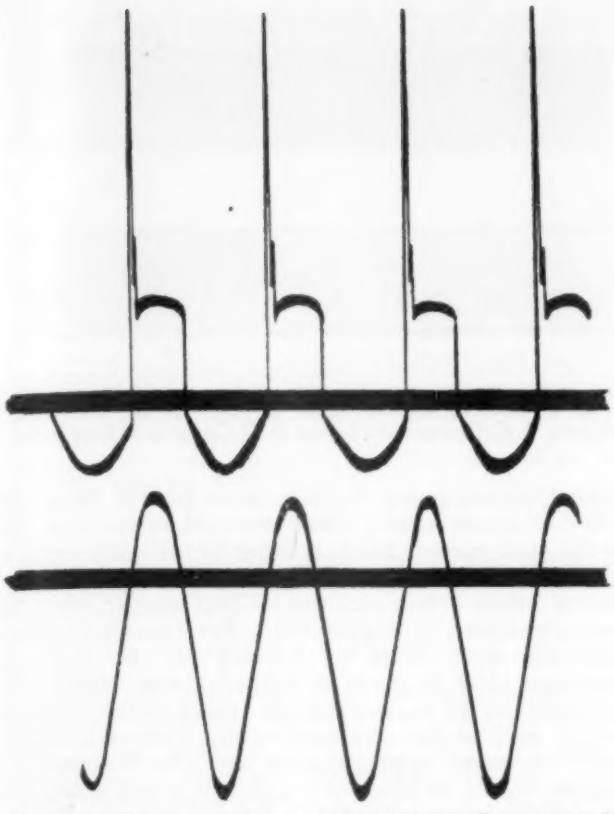


Fig. 1—Oscillogram of Arc in Argon Between Tungsten and Aluminum Standard Arc Welder. Upper Trace, Arc Voltage; Lower Trace, Arc Current

ing a large additional primary current flow to excite the core. The magnitude of the excitation current is dependent somewhat upon design of the transformer, principally air core reactance of the primary winding. Tests on high reactance transformers of the adjustable coil type show a fairly simple rule for estimating input to the windings: the rms input current exceeds the normal for pure a.-c. output by approximately the percentage equal to the percentage of d.-c. component of welding current to total rms. welding current; for example, if d.-c. component is 50% of total output (a.-c. component 86.6%) the primary input will be approximately 150% of normal for 100% pure a.-c. output. This fact has caused trouble with application of standard arc welders to inert-arc welding. In addition to the likelihood of underestimating the output current there is the danger of burning out primary windings because of the high input current; to be safe the input current should be measured.

Saturation of the core causes the input current to contain large amounts of harmonics as is obvious from the oscillogram. Table 1 shows an analysis of input current.

Table 1—Input Current to Arc Welder Welding Aluminum in Argon

	No Capacitors		With Capacitors	
	Amperes	% of 60 Cycles	Amperes	% of 60 Cycles
Total rms.	63.2	105	45.6	117
60-cycle	60.0	100	39.0	100
120-cycle	14.5	24	16.0	41
180-cycle	12.5	21	15.0	39
240-cycle	5.3	9	6.0	15
300-cycle	2.7	5	3.9	10
360-cycle	0.3	..	1.7	4
420-cycle	0	..	3.4	9
480-cycle	0.5	..	1.5	4
Input 60 cycles if no d. c. in sec.	41.5	..	21.8	..

The first two columns show currents when no power factor correcting capacitors are present, the second two columns show input when the usual capacitors are present. It will be seen that the capacitors reduce the 60-cycle component as in any welder but have no substantial effect upon the harmonics. The d.-c. component in the secondary has increased by 50% the input to the welder without capacitors, but has doubled the input to a standard power factor corrected welder. These tests were taken

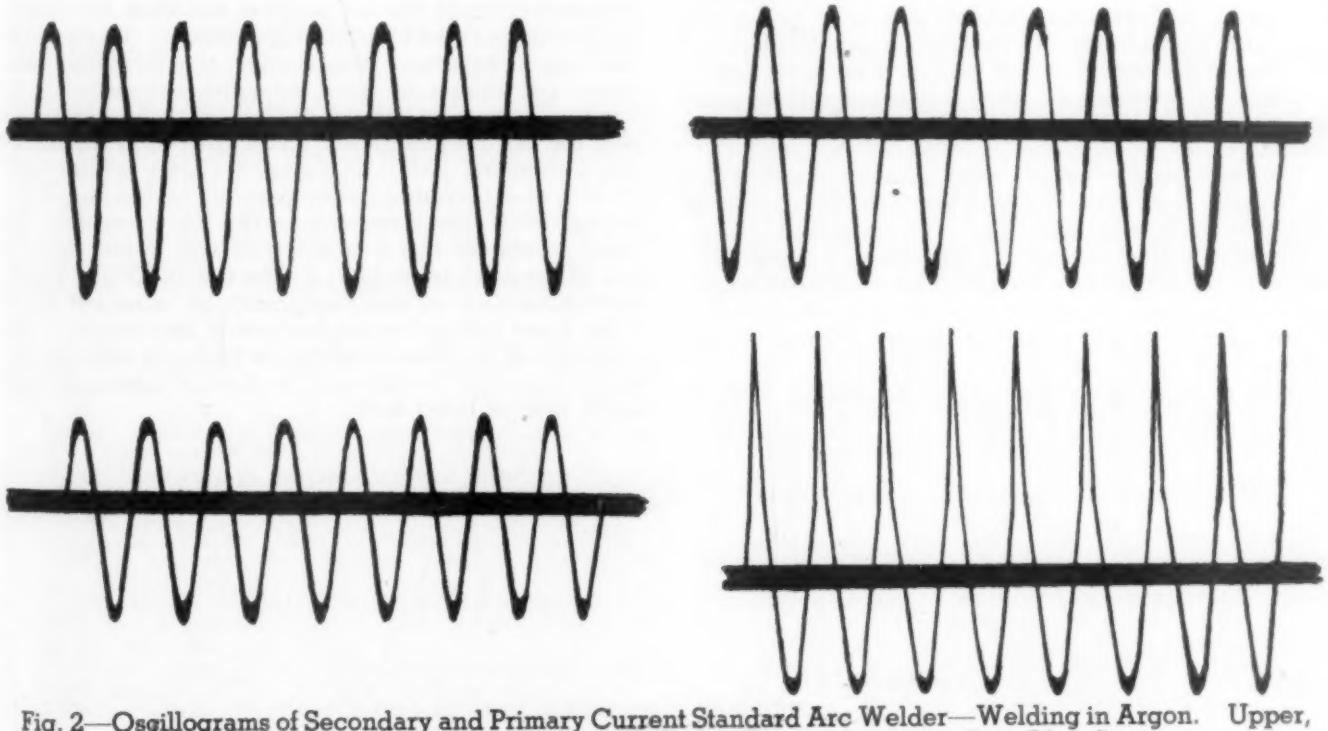


Fig. 2—Oscillograms of Secondary and Primary Current Standard Arc Welder—Welding in Argon. Upper, Secondary Current; Lower, Primary. Left, at Start; Right, 1½ Sec. After Start

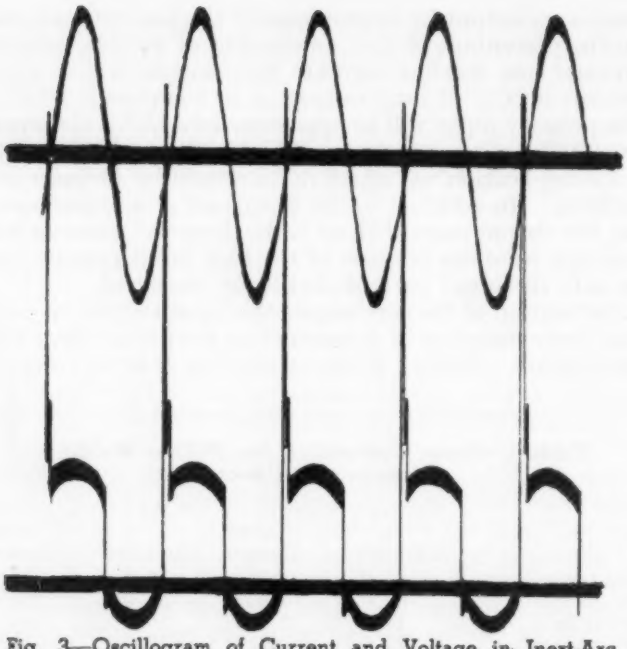


Fig. 3—Oscillogram of Current and Voltage in Inert-Arc Welder; D.-C. Suppressed. Upper, Arc Current; Lower, Arc Voltage

on a standard 200 amp. 75 v. arc welder, total rms. output current 120 amp., d.-c. component 60 amp. (50%), input voltage 220.

It is difficult to generalize upon the effects of harmonic currents in the power system. They are always undesirable but the degree will be determined by system impedances and connected apparatus. In some cases there may be undesirable circulating currents in other equipment such as capacitors or motors. In large installations supplied by exposed circuits telephone interference might be a factor.

The second type of inert-arc welding equipment[1] eliminates all the problems of saturation, harmonics and high input by the use of a low voltage series capacitor in the welding circuit to suppress the d.-c. component. Secondary and primary currents are then practically pure sine waves. The arc stability is greatly increased by this circuit and by a moderate increase in secondary voltage—75 increased to 100 v.—it is possible to eliminate the high-frequency pilot with its attendant radio noise problems.

The oscillograms of Fig. 3 show secondary current and arc voltage with the series capacitor circuit. It will be seen that the half cycles of high arc voltage (work negative) are now 180° instead of approximately 130 to 150° and that simultaneously the current is of normal magnitude rather than being the small portion of an offset wave. Therefore, the power in the arc during the half

[1] Welch, A. U., "Alternating Current Inert-Atmosphere Arc Welder for Aluminum," *Elec. Mfg.*, 40 (10), 135 (1947).

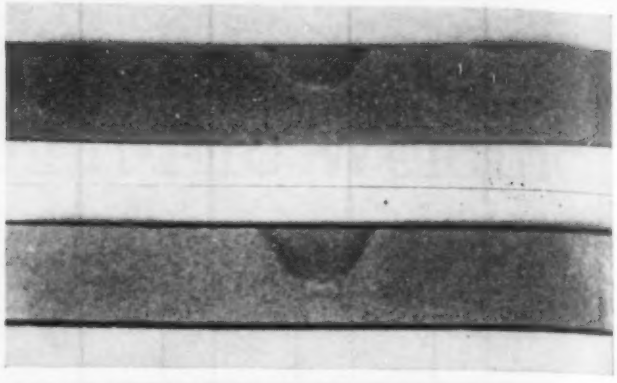


Fig. 4—Relative Melting Effect of Inert-Arc on Aluminum. Upper, D.-C. Component; Lower, D.-C. Component Suppressed

cycle of highest power is much larger than in the circuit with d.-c. component. Thus, it would be expected that for the same current the heat input to the work would be increased and the photographs of Fig. 4 verify this. The area of fusion is broader and slightly deeper when the d.-c. component is suppressed. Tests on both pieces illustrated were made by holding an arc on $^1/_4$-in. aluminum plate in argon at 270 amp. rms., with $^3/_8$-in. arc length at 12 in. per minute travel speed. The increased heat at the electrode requires use of a slightly larger electrode, approximately 20% in diameter, for example $^3/_{16}$ in. in place of $^5/_{32}$ in. It is not within the scope of this paper to include a detailed discussion of the effects of the difference in heat distribution or mechanical arc characteristics as these are problems of welding technique. Both circuits are in wide use successfully. For high-current welding the reduced blasting effect of the arc when the direct current is suppressed is an important consideration. Perhaps as important as any consideration is the greater consistency of the d.-c. suppressed circuit; it is not subject to the uncontrollable variation of d.-c. component caused by variation in set up, leads, transformer size, etc.

Even though the 33% increase of voltage desirable for eliminating the high-frequency pilot increases the kilovolt-ampere input the net input is less than for a 75-v. welder without direct current suppression. To make the following comparison conservative the increased heat output per ampere of the d.-c. suppressed circuit is ignored. Comparing a standard 75-v. 200-amp. arc welder with the usual 5-kva. power factor correction capacitors and a standard 100-v., 200-amp. inert-arc welder with 7.5 kva. of capacitance, both operating at 145 amp. rms. output (38% direct current in the 75 v. welder) the tested inputs are 11.7 kva in the 75 volt welder and 7.6 kva. in the inert-arc welder, a reduction of 35%. Power factor correction cannot practicably be increased much in the lower voltage welder because of two reasons: the capacitors do not remove harmonic currents, and it is undesirable to have the input at no load or minimum load higher than at rated load.

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THE AMERICAN WELDING SOCIETY

ACTIVITIES—RELATED EVENTS

THE FRACTURE OF METALS

Because of the several failures of welded ships during the past few years, an intense interest in the fracture of metals has developed. The monolithic character of welded structures, the fact that crack propagation is fast, the quality (particularly notch sensitivity) of available steels, the design and workmanship have all helped to complicate the problem. Engineers and designers, therefore, must intelligently gain an insight into how, why and when fractures occur so they will be able to build and design safer, more durable structures rather than overdesigning to be safe, which sometimes only increases the possibility of failure.

In publishing in booklet form a report to the Bureau of Ships of the U. S. Navy entitled "The Fracture of Metals," by M. Gensamer, E. Saibel, J. T. Ransom and R. E. Lowrie, the AMERICAN WELDING SOCIETY has provided means for engineers and designers to intelligently approach the problem. The report simultaneously is a summary of reviews of the literature and direct interviews with outstanding men in the field. As such, it represents a compilation of the present knowledge of the laws and the fundamental mechanism of fracture in one booklet for ready reference. From the above it can be understood that ideas presented are a combination of many expert opinions and therefore do not represent the thinking of only one individual on this subject.

The booklet is divided into two parts. Part I includes the original survey of the literature and an analysis of the theories of fracture and applications of principles, while Part II serves as a supplement in that it uses the framework established in Part I to clarify new developments in the theories of fracture and plastic flow. In addition to the extensive bibliography of approximately 300 references, a recommended research program is outlined for those interested.

The survey of the literature discusses the basic concepts and covers the factors involved, such as state of stress, prior strain history, cyclic loading, size effects, temperature, strain rate, composition and structure. Applications of the principles are discussed in relation to the notched-bar impact test and ship cracking.

This booklet and "The Problem of Fracture," by John Hollomon, which was published about a year ago by the AMERICAN WELDING SOCIETY, make it possible to visualize if and how many of the confusing theories are related to each other.

Copies of "The Fracture of Metals," which is priced at one dollar, may be obtained from the AMERICAN WELDING SOCIETY Headquarters, 33 W 39th St., New York 18, N. Y. The usual discounts to members on individual copies will apply.

CHANGE OF ADDRESS

The Membership Department strongly requests that any change of address be promptly submitted to Headquarters so as to avoid delay in receipt of THE WELDING JOURNAL.

It is further requested that the code number assigned the member or subscriber be listed so as to facilitate its location at headquarters.

$2000 IN PRIZES FOR PAPERS ON RESISTANCE WELDING: DESIGN—APPLICATION—RESEARCH

Announcement has been made of cash prizes to be awarded in 1948 by the Resistance Welder Manufacturers' Association for outstanding papers dealing with resistance welding subjects. The total amount of the awards is $2000, and a wide choice in subject matter is allowed in order to assure eligibility to all papers which cover worth while and significant achievements in the field. The contest judges will be appointed by the AMERICAN WELDING SOCIETY, and awards will be made at the 1948 Fall meeting of the SOCIETY. The prizes and rules governing the contest are as follows:

One prize of $750 for the best paper emanating from an industrial source, consulting engineer, private or government laboratory, or the like, the subject matter of which is concerned specifically with resistance welding. There are no restrictions on the scope of the subject matter. For example, it may be devoted to redesign of a product or products for resistance welding, improvement (from a welding and cost viewpoint) in a present design for resistance welding, resistance welding research, development of new procedures to broaden the field of application of resistance welding, etc. Papers in these categories should explain the economic importance of the accomplishments described—that is, cost savings, production improvement, scope of application, etc.

A prize of $500 for the second best paper in the above classification. A prize of $250 for the third best paper in the above classification.

A prize of $300 for the paper emanating from a university source (that is, either an instructor, student or research fellow) which in the opinion of the Board of Award is the greatest original contribution to the advancement and use of resistance welding. A prize of $200 for the second best paper emanating from a university source.

The contest is open to anyone, without restriction, from the United States, its possessions and Canada. It is also open to any member of the AMERICAN WELDING SOCIETY in any grade from any place in the world. The contest is considered as having opened Aug. 1, 1947 and will close on July 31, 1948. In order to be eligible for this contest all papers must be forwarded so as to be delivered at AMERICAN WELDING SOCIETY headquarters no later than 5:00 P.M., July 31, 1948. Papers which are to be presented at the Annual Meeting of the AMERICAN WELDING SOCIETY in October may also be entered in this contest, in which case a draft or copy of the paper must be filed with the AMERICAN WELDING SOCIETY not later than July 31, 1948. To be eligible, author must indicate paper has not been considered previously in the contest, or shall not have been presented or published elsewhere prior to its appearance in THE WELDING JOURNAL.

All papers submitted in the contest become the joint property of the R.W.M.A. and the AMERICAN WELDING SOCIETY, who will retain all rights thereto. The AMERICAN WELDING SOCIETY will appoint five judges, who will judge the relative merits of the various papers submitted and make the awards accordingly. The decision of the judges will be final.

For the author or authors to be eligible for this award, the paper shall describe clearly original work done by them or under their supervision on resistance welding in any of its aspects by any method or process. The paper shall be a full disclosure of the subject. The paper shall contain no statement which is unethical advertising or sales promotion. The paper may contain statements of fact, including the names of either individuals or organizations of any kind, commercial designations, trade names, etc. The minimum length requirement is 2500 words.

All papers must be typewritten, double spaced, written on one side only of blank white paper. Photographs, charts, graphs, etc., may either be attached directly to the copy or may be detached, in which case they should be clearly identified with figure numbers, captions, etc.

Papers entered in this contest should be sent to AMERICAN WELDING SOCIETY, 33 W. 39th St., New York 18, N. Y. If

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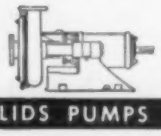

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mailed to arrive not later than July 1, 1948, three copies should be furnished. If mailed to arrive between July 1 and July 31, 1948, six copies should be furnished.

BOARD OF DIRECTORS MEETING

A meeting of the Board of Directors of the AMERICAN WELDING SOCIETY was held in the Grover Cleveland Room of the Statler Hotel, Buffalo, N. Y., on Feb. 26, 1948, with the following present:

Members: H. O. Hill, Chairman; D. Arnott, D. H. Corey, R. S. Donald, O. B. J. Fraser, W. F. Hess, G. O. Hoglund, T. M. Jackson, C. I. MacGuffie, L. S. McPhee, H. W. Pierce, R. D. Thomas, J. B. Tinnon and G. M. Trefts III.

Guests: C. E. Jackson, Ogden Mills, R. Hoagland, P. E. Gardner, R. Lyall and I. Morrison.

Staff: M. M. Kelly, *Secretary.*

Proceedings

Officers and Executive Committee members of the Western New York Section were introduced and invited to participate in the discussion.

Withdrawal and Disbursement of A.W.S. Permanent Funds

The Board Voted: To authorize the withdrawal and disbursement from the Permanent Fund of the SOCIETY of an amount not to exceed in total $50,000, and not to exceed $18,000 in any one year, for reason of giving assurance that the program of establishing and maintaining an Executive Secretary of the SOCIETY can be financed for at least three years, but with the understanding that withdrawal from the Permanent Fund of the Society shall be made only if it is found that the general funds of the SOCIETY are insufficient to meet this expense, and further with the understanding that authorization for definite sums to be withdrawn from the Permanent Fund shall be subject to subsequent Board action, when such withdrawal is found necessary.

Membership, Reclassification, Dues and Benefits

The consensus was that some increase in dues is inevitable at this time. The By-Law Amendments and Rulings, as shown in the March Journal were approved.

Proposed Amendments of By-Laws, Articles VII—"Officers and Terms of Office," X—"Management," XII—"Committees," and Rulings of the Board of Directors

Mr. Hill explained that the proposed By-Law amendments, submitted to the Directors for study with the agenda of this meeting, are to provide for the office of Executive Secretary and to improve procedure of operation of the SOCIETY. The amendments have been prepared by the Committee on Constitution and By-Laws, in cooperation with the Special Committee on A.W.S. Organization. Changes in the proposed revisions suggested at this meeting were considered carefully, after which, upon motion duly made, and seconded, the By-Law amendments and Rulings, as shown in the March issue of the JOURNAL, page 225, were approved.

Staff Organization Chart

Upon motion duly made, and seconded, the chart and explanation of duties of A.W.S. Staff were accepted as a report of the A.W.S. Committee on Organization.

Appointments—A.W.S. Standing and Special Committees

Changes.—Education Committee: Resignation—R. W. Clark, General Electric Co., Schenectady, N. Y.; H. F. Reinhard, Union Carbide & Carbon Co., New York City.

The Board voted acceptance of resignation of these members.

Program Committee: Resignation—K. H. Koopman, The Linde Air Products Co., Newark, N. J. Replacement—R. M. Wilson, Jr., The International Nickel Co., New York City.

The Board voted acceptance of resignation of Mr. Koopman and of the appointment of R. M. Wilson, Jr., as a member of the Program Committee.

Addition.—Welding Handbook Committee: The Board voted approval of appointment of J. G. Magrath to the membership of the Welding Handbook Committee.

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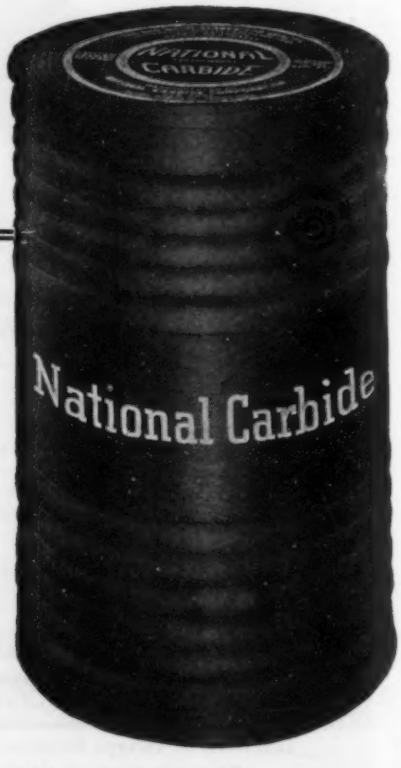

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RACO Composite Type A is a heavily coated electrode in coils, providing the same physical results as heavily coated manual electrodes. With RACO Composite Type A, extremely high speeds can be obtained.
It can be used with all standard automatic arc welding heads with the addition of adapter and contact device illustrated.
RACO Composite Type A can be had with any of the following coatings—A.W.S. 6012; 6020; 6030; 7020; 7030, and corresponding high tensile grades A.W.S. 8020; 8030; 9020; 9030; 10020; 10030. This electrode can also be furnished in three grades of hard surfacing material for building-up—RACO 25 (20-25 Rockwell C), RACO 45 (40-50 Rockwell C) and RACO 55 (50-60 Rockwell C). RACO Composite Type A Electrode is furnished in the following sizes: No. 8 (approx. 3/8"), No. 7 (approx. 5/16"), No. 6 (approx. 1/4"), No. 5 (approx. 1/32"), No. 4 (approx. 3/16"), and No. 3 (approx. 5/32"). Coils are 36 inches I.D., and weigh 100 to 150 pounds net.
LIGHTLY COATED AUTOMATIC ELECTRODES:—RACO Types "D", "M", M-9 (Knurled), Plain Mill Finish and Copper Coated Wire in coils.
We draw a full line of copper coated oxy-acetylene welding wires. Furnished in coils and straightened and cut lengths.
We further manufacture a complete line of heavy coated manual electrodes for welding:—Mild Steel—High Tensile Steels—Stainless Steel—Manganese Steel—Cast Iron—Nickel—Monel—Inconel and Aluminized Steel.
Write for full information.
The REID-AVERY COMPANY
INCORPORATED
DUNDALK · BALTIMORE 22 · MARYLAND
SINCE 1919 PRODUCERS OF ARC WELDING ELECTRODES AND WELDING RODS

Policy in Respect to A.W.S. Staff Officers Serving on Awards Committee of Other Societies

The Board voted approval of staff officers serving on honor committees of other societies.

T.A.C. Recommendations

After due consideration, the Board voted to approve recommendations of T.A.C. in respect to:

1. Disbandment of Committee on Standards Procedures of Welding and Standards for Welded Joints.
2. Appointment of J. H. Deppeler as A.W.S. representative on Technical Committee of Way and Structures Division of the American Transit Association.
3. Appointment of S. A. Greenberg as A.W.S. representative on Welding Committee of the National Elevator Manufacturing Industry.

The Board received report on status of Committee on Standard Qualification Procedures and on the replacement of H. W. Pierce by R. W. Clark as Chairman of this Committee.

Finances

Report on financial operations of the SOCIETY for the first quarter of the fiscal year, commencing Oct. 1, 1947, was briefly reviewed by the Treasurer. He drew attention to the fact that operations for the month of December 1947 showed an excess of expense over income of $663.16, as against an excess of income over expense of $6,002.19, a year ago, which he pointed out is due partially to the increased cost of our regular operations, and in part to the enlarged program of activity undertaken in behalf of the Sections. The black figure shown for operations during the first quarter of the fiscal year ending December 31, 1947 is attributable to the fact that revenue from the National Metal Exposition is included in this period, and also to the fact that some economies have been effected. Comparison of actual operation with the budget for the three-month period shows, on the income side, slight reduction in JOURNAL advertising and from *Supplement* and, on the expense side, savings in THE WELDING JOURNAL publication and some reduction in expenses of administration, Section and membership activities, which is due to delay in carrying out the Sectional and membership programs.

The Treasurer sounded a warning note regarding the necessity of bringing in new money of the order of $29,500 to meet budgeted expenses for the current fiscal year. JOURNAL expenses have been cut by reducing the size of the JOURNAL. Further reduction is deemed most inadvisable. Reduction in other operational costs is impossible without seriously jeopardizing services to the membership, Sections and industry. It appears, therefore, that we must turn to the proposed increase in dues and a large gain in membership to meet our current expenses and the cost of the enlarged activity program. The membership and Sections should be made aware of that fact.

Report of the Treasurer on the financial operations of the SOCIETY for the first quarter of the fiscal year, commencing Oct. 1, 1947, was accepted.

Date, Time and Place of Next Meeting

Announcement was made by the President that the next meeting of the Board of Directors will be held in the Engineers Club, Philadelphia, Pa., on May 17, 1948.

GAS CYLINDER BOOKLET

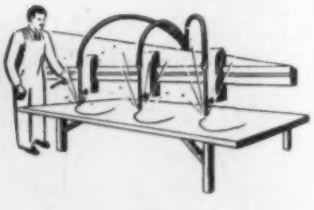
The Taylor-Wharton Iron & Steel Co. of Easton, Pa., has just issued a new 16-page booklet describing the Taylor-Wharton seamless high pressure gas cylinders. These cylinders are widely used in the compressed gas industry. The booklet describes the various tests performed and methods used to insure uniformity. The booklet gives full information on sizes, weights, etc. Available on request.

FOR THESE JOBS . . .

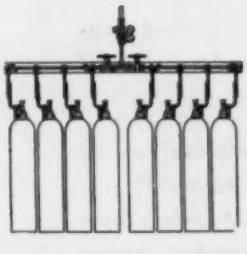
Production Welding

. . . and operations such as welding and cutting heavy sections with hand torches, flame hardening and softening, flame cleaning . . . also any installation where a battery of cylinders is required.

Production Cutting

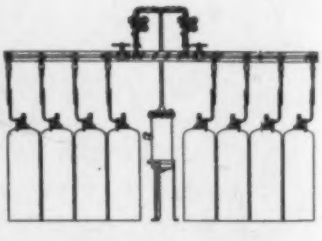


YOU NEED THESE MANIFOLDS . . .



REGO Oxygen Manifold

REGO Acetylene Manifold



BECAUSE OF THESE ADVANTAGES...

● *Added Convenience*...Individual shut-off valves at each cylinder station permit the removal of any cylinder without shutting down one side of the manifold. Master shut-off valves control flow of each bank of cylinders.

● *Unit Construction*...Header assembly, mounted to steel I-beam, is virtually one piece. Extra-heavy pipe is run through header fittings, cylinder station shut-off valves and master shut-off valves with all permanent connections silver-brazed.

● *Precision Regulation*...Uniform delivery pressure is assured by large capacity two-stage Regulators.

● *Exacting Tests* . . . Every RegO Manifold is subjected to a sustained air pressure test before shipment.

REGO® Manifolds for Oxygen . . . Acetylene . . . Hydrogen . . . Nitrogen and other high pressure gases

There Is A RegO Manifold to Fit Your Most Exacting Requirements

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Pioneer and Leader in the Design and Manufacture of Precision Equipment For Using and Controlling High Pressure Gases

BLUE DEVIL E 6010
BLUEDAC E 6011
GRAY DEVIL E 6012
GRAY DEVIL No 2 E 6012
GRAYDAC E 6013
BLACK DEVIL E 6020
RED DEVIL E 6030
BLACK DEVIL No 75 E 7020
RED DEVIL No 75 E 7030

For Welds of Champion Caliber . . . Choose CHAMPION Welding Rods!

Mild Steel Electrodes

BLUE DEVIL	All Position, Reverse Polarity	A.W.S. 6010
BLUEDAC	All Position, A. C. Current	A.W.S. 6011
GRAY DEVIL	General Purpose, Poor Fit-up Straight Polarity	A.W.S. 6012
GRAY DEVIL No. 2 . .	General Purpose, Smooth Bead Straight Polarity Also A.C. Current	A.W.S. 6012
GRAYDAC	General Purpose, Smooth Bead Straight Polarity Also A.C. Current	A.W.S. 6013
BLACK DEVIL	Deep Grooves and Horizontal Fillets Straight Polarity	A.W.S. 6020
RED DEVIL	Deep Grooves, Reverse Polarity	A.W.S. 6030
BLACK DEVIL F. B. . .	Finishing Beads for Smooth Cover Beads	A.W.S. 6030

High Tensile Electrodes

BLUE DEVIL 85	All Position, Reverse Polarity	A.W.S. 7010
BLACK DEVIL 75 . . .	Deep Grooves and Horizontal Fillets	A.W.S. 7020
RED DEVIL 75	Deep Grooves, Reverse Polarity	A.W.S. 7030

Special Electrodes and Acetylene Rods

Stainless Steel Electrodes All Types

Electrodes & Acetylene Rods for Cast Iron Welding

Bronze and Copper Alloy Electrodes and Acetylene Rods

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Hard Surfacing Electrodes

Aluminum Electrodes and Acetylene Rods

High Carbon, Alloy and Manganese-Nickel Electrodes for Rail Welding

Mild Steel Bare and Lightly Coated Electrodes

Mild Steel and High Carbon Acetylene Rods

WELDING ACCESSORIES

Chipping Goggles
Welding Machines: A.C. Transformer Types
Welding Goggles
Welding Cleaning Tools
Welding Clamps
Safety Clothing
Welding Gloves
Carbon Paste & Fluxes
Welding Cable Connectors
Welding Carbons
Carbon Plates
Welding Cable
Weld Spatter Eliminator
Electrode Holders

CHAMPION Electrodes are Weld Rated Electrodes

THE CHAMPION RIVET CO.

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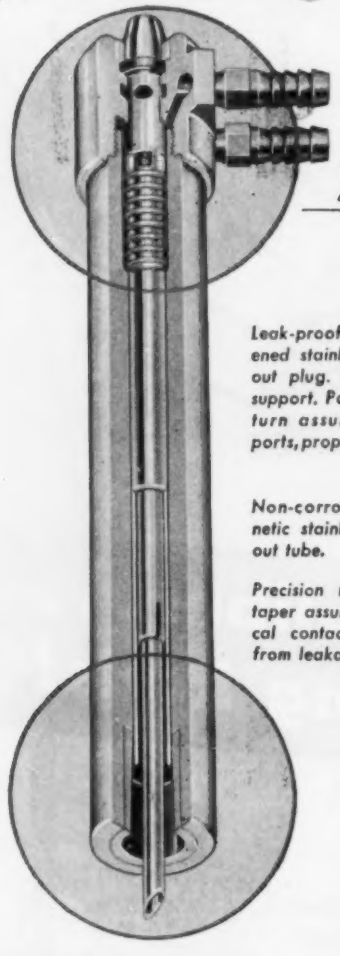
"RAINCOATS"
for Welding Electrode Holders!



Leak-proof water seal hardened stainless steel knock-out plug. Double bearing support. Positive spring return assures free water ports, proper seating of tip.

Non-corroding non-magnetic stainless steel knock-out tube.

Precision machined Morse taper assures tight electrical contact and freedom from leakage.

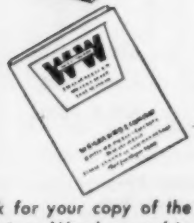
HEAVY DUTY WATER-COOLED ELECTRODE HOLDERS ARE POSITIVELY LEAK-PROOF

Weiger-Weed engineers have put "raincoats" on WW water-cooled holders to make them really leak-proof—a fact absolutely demonstrated by hundreds of Weiger-Weed holders in service. Regardless of water pressure or temperature, Weiger-Weed holders do not leak. Here is an outstanding holder designed to end all holder trouble.

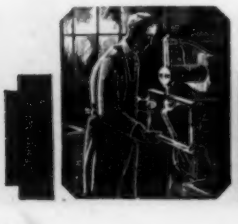
Hard WW alloy taper socket of high electrical conductivity. Will not get out of round or leak.

To supplement this efficiency—always use Weiger-Weed Spot Welding Tips. They give you good, sound welds with fewer dressings at lower cost. Made from Weiger-Weed special copper base alloys, they combine high electrical conductivity with greater wear resistance. You can get most sizes and shapes—pointed, radius, flat and offset—promptly from stock. Weiger-Weed also manufactures electrodes and parts for other resistance welding processes—seam welding wheels, flash, butt and projection welding dies, current-carrying shafts and bushings.

Weiger-Weed places at your service its special engineering and production skills to solve unusual resistance welding problems. Write for specific recommendations on your problem. Weiger-Weed & Company, Division of Fansteel Metallurgical Corporation, 11644 Cloverdale Avenue, Detroit 4, Michigan.



Ask for your copy of the Weiger-Weed manual to become familiar with Weiger-Weed products and service, to help you turn out stronger, lighter, more easily fabricated products at lower cost.



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TRADE MARK
Resistance Welding ELECTRODES
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DIVISION OF FANSTEEL METALLURGICAL CORPORATION

PRECISION INVESTMENT CASTINGS

Precision Investment Castings was written by Edwin Laird Cady, and published by Reinhold Publishing Corp., 330 W. 42nd St., New York, N. Y. Price $6.00. Precision investment casting is far from being widely familiar to engineers. Therefore, a carefully calculated attempt has been made in this book to put each bit of information where the engineer will need to be considering it and thus eliminate unnecessary checking back and forth in the perfection of his designs and production plans.

The first few chapters should serve to tell the engineer what precision investment casting is, what it does and how it does it. From these chapters he can make up his mind as to whether precision investment casting has anything to offer him or not, and whether it is a process which he should operate in his own shop or one for the products of which he should turn to outside suppliers.

The remaining chapters go on to tell the engineer what must be done in product design and redesign in order to get the best results from precision investment casting, and how the process can be operated to obtain the desired ends. The resources and weaknesses of the process are described, the predictable lines of its future development are clearly indicated, and the practical methods by which the process may be operated on a sound basis are analyzed.

DESIGNER'S GUIDE FOR WELDED CONSTRUCTION

The growing use of welded design and thus the greatly increased value of properly indicating welds on drawings are recognized in an attractive six-page folder "Designer's Guide for Welded Construction."

This folder is of such form that it can be placed under a desk glass or thumb-tacked to a drawing board for quick reference. Readers can secure copies by addressing The Lincoln Electric Co., Cleveland 1, Ohio.

BLACK, SIVALLS & BRYSON PAMPHLETS

Black, Sivalls & Bryson, Inc., 720 Delaware, Kansas City 6, Mo., has just issued five attractive pamphlets on the following subjects:

Butane-Propane Skid Tanks for drilling rigs, pump units, industrial users, and farm users.

Dependable Valves for Salt Water Disposal Service.

The Phantom Pumper which enables remote control of oil wells and tanks from a centralized panel.

Farm Storage Tanks—elevated and skid farm tanks, basement fuel oil tanks.

Bigger, Stronger & Better Weldments.

Sections of aluminum strip 4 inches wide and 5/16 of an inch thick are being butt welded together by the Inert-Arc process to form a continuous band which is shown being wound on the cyclotron under construction at the left.

Inert-Arc Aids Atom Smashers!

. . . welds to withstand cyclotron stresses

Inert-Arc welding has played an important part in the building of a cyclotron at the University of Rochester, to be used for further investigation of the atom.

It is essential that the construction be able to withstand considerable mechanical stress. Inert-Arc was chosen as being the most practical method for the joining of the aluminum windings; since Inert-Arc makes possible strong, ductile joints of high electrical conductivity, without adding to the thickness of the strip.

The Inert-Arc process is exceptionally versatile. Today, manufacturers of stainless steel sinks and food containers, aluminum barrels and pistons, as well as innumerable other items and metals, are employing Inert-Arc, both machine and manual, in high-speed production. The process is well demonstrated in the new G-E film, "Arc Welding at Work"; your G-E Arc-welding Distributor will show it to you.

The General Electric, Type WP, Inert-Arc welder. A completely self-contained power unit specifically built for inert-gas-shielded arc welding without flux. This welder is designed to produce welds with better contour and deeper penetration; while gas consumption has been reduced as much as 20 to 30 per cent in actual production welding applications.

Regardless of what your welding problems may be, see your local G-E Arc-welding Distributor—or write Apparatus Department, General Electric Co., Schenectady 5, N. Y.

"A-C or D-C . . . there's G-E Arc-welding Equipment for Every Application!"

ARC WELDERS • ELECTRODES • ACCESSORIES

GENERAL ELECTRIC

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COMMUNICATION TO THE EDITOR

THE LINCOLN ELECTRIC COMPANY
12818 Coit Road
Cleveland 1, Ohio

February 25, 1948

Editor
THE WELDING JOURNAL
New York, New York

MY DEAR SIR:

Welding construction is being handicapped by code writers putting restrictions of no value, but of great expense, on welded structures made under their codes. Part of these handicaps come from the desire of certain manufacturers, equipped with certain unusual facilities, to exclude from competition those who do not have such facilities. Part of it is lack of knowledge on the part of the writers of the codes. Part of it seems to be plain cussedness. The following illustrations will show some of the distortions used to limit welding and to increase its cost.

The method of joining steel plates has been the riveted joint for generations. Results have been satisfactory, yet it is impossible to make a riveted joint as strong as the parent metal. It is, however, impossible in mild steel to make a welded joint of equal sections which is not stronger and will not break the plate in tension. However, the code writers, in spite of these facts, make the following restrictions on welded structures:

If a welded joint is made of equal strength to a riveted joint, the riveted joint is accepted, the welded joint rejected.

If a welded joint is made of equal ductility to a riveted joint, the riveted joint is accepted, the welded joint rejected.

If a welded joint is made with the same undercut from caulking, as is normally done in a riveted joint, the riveted joint is accepted, the welded joint rejected.

If a welded joint is made with the same porosity as a riveted joint, the riveted joint is accepted, the welded joint rejected.

If Magnaflux or X-ray is used on a welded joint and it shows the same voids as it would on a riveted joint, the welded joint would be rejected, the riveted joint accepted.

If a welded joint is made with the same surface appearance as a riveted joint, the welded joint would be rejected, the riveted joint accepted.

If a welded joint is made with the same fatigue value as a riveted joint, the riveted joint would be accepted, the welded joint rejected.

If a welded joint is made with the same tightness as a riveted joint, the riveted joint would be accepted, the welded joint rejected.

If a welded joint is made with the same tendency toward caustic embitterment as a riveted joint, the welded joint would be rejected, the riveted joint accepted.

There has never been a weld failure in any insured pressure vessel. In spite of this, progressively greater handicaps are placed on welding whose sole purpose is to make welded structures cost more. Already there have been billions of dollars unnecessarily wasted in this way.

Perhaps what we need is a new code for welding code writers rather than for welded constructions. Perhaps we can then deal with reality in this matter.

Very truly yours,

J. F. LINCOLN, *President*

KEATING MADE DISTRICT ADMINISTRATOR

L. M. Keating, assistant to the president in charge of distribution of the A. O. Smith Corp., has been appointed executive administrator of the company's Southwest District Office in Houston, Tex., it was announced recently by W. C. Heath, president. Mr. Keating replaces B. F. Bart, recently deceased.

In making the announcement Mr. Heath said, "The nine great states in our Southwest District account for almost 25% of the company's total business. The present growth and development of the area is so rapid that our interests there must be put in the hands of the most competent administrator we can spare from our central management."

Mr. Keating is a native Texan, and graduated from the engineering school of Washington University.

Prior to joining A. O. Smith in 1936, Mr. Keating's interest in engineering, marketing and administration brought

him prominent identification in a variety of fields. These activities included sales administration of technical products and jobbing. He spent five years with the McGraw-Hill Publishing Co. in Cleveland and New York. He was also active in planning the marketing of major home appliances.

Mr. Keating's first assignment with A. O. Smith was to inaugurate a program of product diversification. He participated in the development of a glass-line tank for home water heaters, which has since become one of the company's principal businesses.

A later assignment was to develop a national market for welding electrodes and equipment. During the war he supervised the design and construction of the company's Houston electrode plant, which has since been converted to the manufacture of liquid gas systems, pressure vessels and vertical turbine pumps. Since 1937 he has worked closely with both manufacturing and sales executives in producing and distributing company products for the petroleum industry such as casing line pipe, pressure vessels, meters, pumps and the like.

FOR SALE!

ARC WELDERS

1942-1944 Models-Excellent Condition At less than ½ their cost!

IMMEDIATE DELIVERY!

300 AMPS — Motor Driven — 3 Phase — 60 Cycles Wilson Hornet — Westinghouse — Hobart — 220/440 volts
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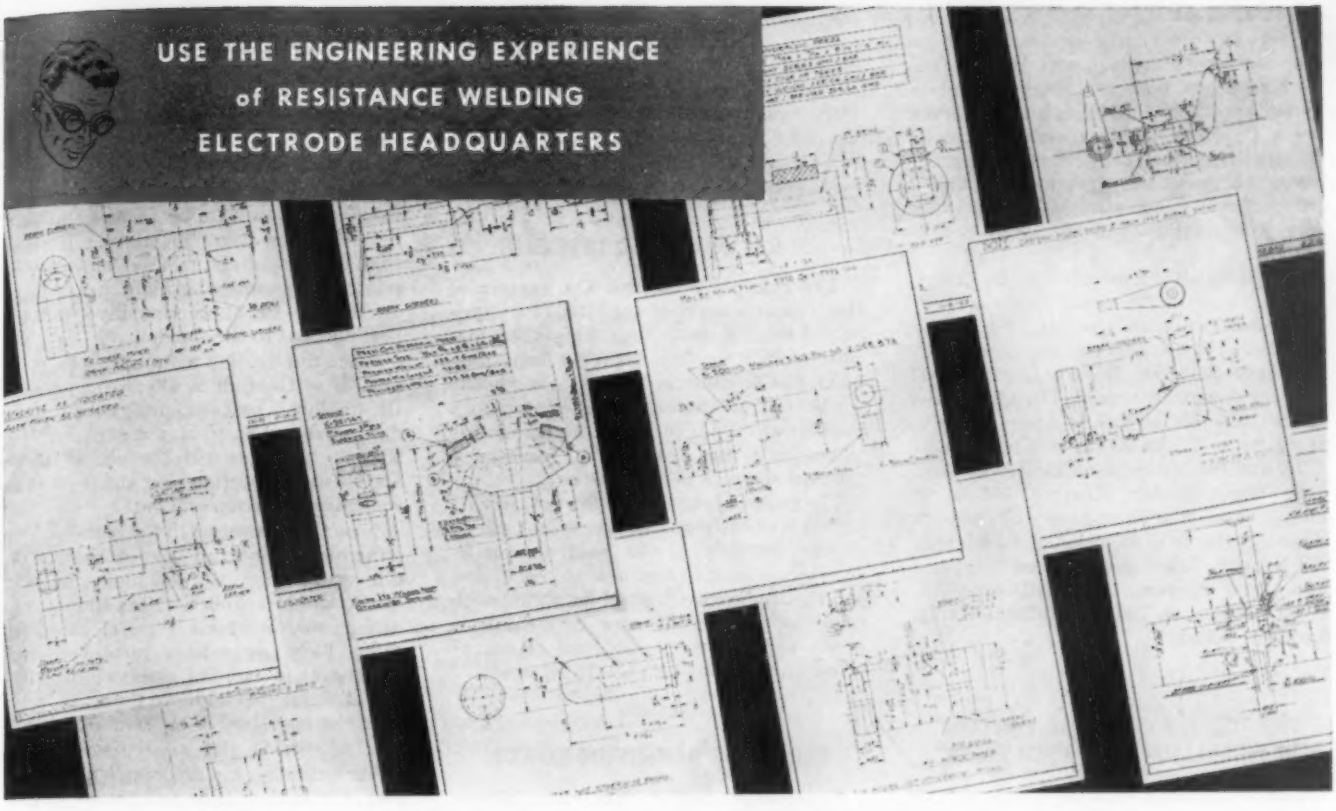
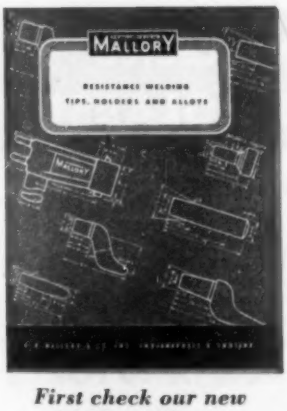


Special Tips and Holders?

Our Files May Contain The Right Answers For You



First check our new 1948 catalog—

"Mallory Resistance Welding Tips, Holders and Alloys."

It contains everything you want to know about Mallory standardized welding electrodes, holders, replacement parts, accessories, seam welding wheels, dies, and special alloy applications for Resistance Welding.

If it isn't there—get in touch with Mallory direct.

The drawings shown here are only a few of the thousands that are cataloged and indexed in the Mallory resistance welding engineering files.

For the past 20 years we have been designing special resistance welding electrodes to handle jobs for which standard equipment was inadequate.

As a result we now find that many of these "special" problems presented to us are promptly answered at a great saving of time and expense by a design already in our files.

That's why it pays to check with Mallory--first to see if the widely interchangeable line of standard Mallory tips and water-cooled holders will not handle your job—and next to see if a special design from Mallory's extensive files won't handle it at a substantial saving to you.

Remember, Mallory is the only supplier of resistance welding materials with a completely equipped research laboratory and engineering department specifically devoted to problems that arise in this field.

In the United Kingdom, made and sold by MALLORY METALLURGICAL PRODUCTS, LTD.
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RWMA

THE PIONEERS OF ELKONITE*, ELKALOY A*, MALLORY 3*, MALLORY 53B and MALLORY 100 METALS.

P. R. MALLORY & CO. Inc.

MALLORY RESISTANCE WELDING MATERIALS

ELECTRODES—HOLDERS—SPECIAL DIES AND FIXTURES—
ELKONITE* METALS—ALLOY ROD AND BAR STOCK—
FORGINGS—CASTINGS—ACCESSORIES *REG. U. S. PAT. OFF.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For the past three years, he has served as executive in charge of distribution on the company's management staff. Thus to his present post he brings not only a broad experience in the industries served by A. O. Smith, together with an intimate familiarity with all of the company's products, processes and personnel, but also a sympathetic understanding of the problems and conditions of his native Southwest.

Mr. Keating is a member of the American Institute of Electrical Engineers, the American Petroleum Institute, the American Society for Metals, the AMERICAN WELDING SOCIETY, Rotary International and the American Legion. In Milwaukee he is a member of the Engineers Society, University Club, Athletic Club, Press Club and the Milwaukee Country Club.

In Houston, Mr. Keating will be in charge of all of the company's interests in Texas, Missouri, Louisiana, Oklahoma, Mississippi, Arkansas, Kansas, Colorado and New Mexico, and will supervise branch offices in Dallas, Midland, Tulsa and New Orleans.

THE USE OF GASEOUS OXYGEN IN METALLURGICAL PROCESSES

The availability of a new reprint entitled "The Use of Gaseous Oxygen in Metallurgical Processes" has been announced by the Air Reduction Sales Co. Written by Dr. G. V. Slottman and P. M. Hulme, this new 12-page reprint originally appeared in *Metal Progress*. The article offers latest information on the metallurgical uses of oxygen in steel making, with emphasis on open hearth applications.

For a free copy of this new reprint write Department 1867P, Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y., or the Airco sales office nearest you.

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25 CR–20 NI WELD DEPOSITS

The Babcock & Wilcox Co. announces that reprints are now available of a paper on "Some Factors Controlling the Ductility of 25% Cr–20% Ni Weld Deposits," by O. R. Carpenter and N. C. Jessen of the works control laboratory of the company's Barberton (Ohio) plant. The paper was presented at the 1947 annual meeting of the AMERICAN WELDING SOCIETY.

The paper discusses the effect of varying amounts of carbon, manganese and silicon on the ductility of the weld deposit as determined on different heats of core wire, and the application of the data obtained to enable specifying of core wire analysis which will produce a minimum of microdefects in deposited 25 Cr–20 Ni welds.

REPAIRING ALUMINUM BOATS

By Charles Bruno, Reynolds Metals Co., Louisville 1, Ky. Increasing number of aluminum boats now being used for pleasure, hunting, fishing, etc., has resulted in many requests for recommendations on the repair of tears or breaks in the hull.

First it should be emphasized that only a welder who has had some previous experience in the welding of aluminum should attempt to weld an aluminum boat. However, most job and repair shops have welding operators familiar with aluminum and its welding characteristics.

Any tears or breaks 6 in. or more from wood members can be repaired without removing the wood members. If closer than 6 in., the wood member must first be removed, because the high thermal conductivity of the aluminum may spread the welding heat to the wood.

Since the welding will be done from the outside of the hull in all cases, and since the welding is best done with the seam in a flat horizontal position, the next step is to turn the boat over with the bottom side up and in such a postion that the seam to be welded is at the top and flat.

Now the torn metal in the hull should be straightened out and formed back to the original position, using a mallet made of leather or hard rubber. Next all the metal surface within about 1 in. of the crack should have any paint or varnish removed by sanding it with fine emery cloth of 180-grit or finer. Metal more than 1 in. away from the break on either side need not be touched.

Arc welding is not recommended. However, the Heliarc (shielded gas arc method using argon) is highly recommended, and can be used to advantage where the special equipment required is available. In most cases, the welding will be done with the oxyacetylene gas welding torch, using a No. 2 welding tip.

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BUILT FOR BETTER SERVICE•BUILT FOR BETTER SERVICE•BUILT FOR BETTER

Lightweight, Sturdy Protection . . .

● DOCKSON cover-spectacle goggles are hard to beat. Designed for maximum comfort and ample ventilation, they are light weight, non-fogging and sturdy.

Replaceable lenses to your specifications, permit wide vision range. Rigid brace bar allows easy adjustment and convenient raising and lowering with one hand.

These goggles offer maximum protection and comfort. Available for chipping, grinding or welding use.

(Write for our Welding & Safety Equipment Catalogs)

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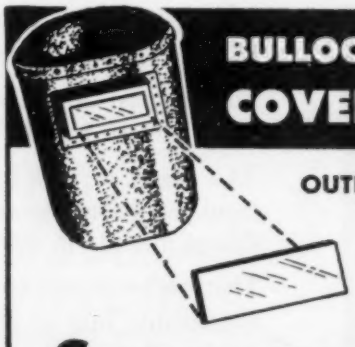

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OUTLAST OTHERS 10 to 1
SPLATTERPROOF
WATERPROOF
BETTER VISION

SEND FOR A TEST BOX OF 10 FOR $1

LIST PRICES
15c EACH
100 for $12.00
500 for $45.00
1000 for $67.50

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Also 50 mm. Goggle Glasses

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A good aluminum welding flux (such as Anti-Borax Co., Ft. Wayne, Ind., Flux No. 8, or General Electric Co.'s Aluminum Welding Flux) should now be mixed with water to form a paste suitable for application with brush. After painting it on and around the crack, actual welding may begin.

It is not necessary to back up the seam during welding. The aluminum filler rod should be $^1/_8$ or $^5/_{32}$-in. diam., the size recommended for repairing Reynolds boats, all of which have hulls of 0.064-in. R361 aluminum alloy. The rod should be of the 5% silicon type (such as the Linde Air Products No. 23 Welding Rod) which may be purchased at any welding supply house.

Where the crack is more than 6 in. long, actual welding begins by tacking the seam at 1-in. intervals. This helps avoid buckling and distortion during welding. Actual welding is done by the "puddling" method in which the parent or base metal is puddled with the filler rod. Care must be taken not to overheat the metal as this could easily result in melting away a section of the hull. Remember aluminum melts at about 1200° F. whereas it takes some 2800° F. to melt steel.

After welding, the outer weld surface should be ground off smooth with the hull surface. The inner surface can also be ground smooth if desired. If the grinding does not remove all the surplus welding flux, clean it off with a 5% solution of nitric acid applied with a rag or brush. Then rinse off carefully with clear water.

The boat is now as good as new, and if the job is done skillfully, it will be almost impossible to detect where the weld was made.

ELEMENTARY PHYSICAL METALLURGY

Interestingly written by Edward G. Mahin, Ph.D., this is an authoritative text for beginners in the study of metallurgy. The discussions of fundamental metallurgical facts and theories are developed in such fashion as to make the book valuable as a short course for mechanical, electrical, chemical and aeronautical engineers as well as an introductory text for majors in the metallurgy field.

Special attention is given to fundamentals and care has been taken not to encumber the book with abstruse conceptions.

Starting with the microscope and the preparation of metallographic specimens the book deals with the fundamental properties of materials and their relationship to one another, methods of testing and the interpretation of the test results.

Outstanding features of the book are the detailed treatments of hardness, thermal analysis, pyrometry and phase diagrams. The author succeeds in making these sections live enough to hold the interest of students and engineers alike.

Price $6.00. Published by Remsen Press Division, Chemical Publishing Co., Inc., Brooklyn 2, N. Y.

NEW COLOR MOVIE ON "DESIGNING MACHINERY FOR ARC WELDING"

To assist the designer and engineer to use arc-welded steel in the design of all types of machinery in many hundreds of different industries, The Lincoln Electric Co. has recently released a new movie, "Designing Machinery for Arc Welding."

Based on the experience machinery manufacturers have had in using welded steel fabrication to improve performance and quality while reducing cost, this 16-mm. sound color movie gives examples of the four fundamental elements of all machinery: bases, wheels, containers and covers. In colorful and vivid animation, it compares various materials and presents a study of load factors, stresses, rigidity, performance and appearance. It explains how welded design permits freedom of planning, speeds up fabrication, reduces weight and permits greater strength from less material.

The film presents *functional* approach to design. Its theme is to use "the right material" of only the "right amount" in only the "right places." In other words, to design to meet service requirements *exactly* at minimum cost.

The new movie, which has a running time of approximately 15 minutes, is available from The Lincoln Electric Co., Cleveland, Ohio, at no charge (except transportation) by all interested industrial organizations, technical societies, schools, colleges, etc.

FLOATING DRYDOCK

A 400-ton capacity floating drydock for the Erie Railroad Co. was launched into the Christiana River recently at the shipyard of Dravo Corp.

Of welded steel construction, the drydock is 110 ft. long, 60 ft. wide and 27 ft. high. It will be used in New York Harbor for maintenance and repair of tugs and other marine equipment operated by the Erie Railroad.

The vessel was prefabricated at Dravo's Pittsburgh shipyard and transported to Wilmington for final assembly.

TECHNICAL BOOKS

A new, 1948 catalog of technical books has just been issued by The Chemical Publishing Co., Inc., 26 Court St., Brooklyn 2, N. Y. This catalog includes the latest books on chemistry, physics, science, technology, petroleum, medicine, foods, formularies, drugs and cosmetics, engineering, metals, technical dictionaries, building construction, etc.

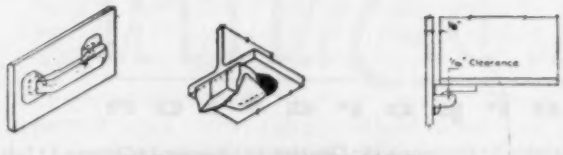
This catalog, conforming with the requests of technical and scientific workers and librarians, gives the date of publication of each book as well as price, number of pages, detailed descriptions and full table of contents.

A copy of this catalog will be sent free to everyone who is interested in keeping up with the latest technical and scientific progress.

STRENGTH OF MATERIALS

Strength of Materials, by Joseph Marin, Professor of Engineering Mechanics, The Pennsylvania State College. Published by the Macmillan Co., 60 Fifth Ave., New York, 1948. Price $4.75.

The material in this book has been selected for use as a text in a first course in Strength of Materials. One of the main features of the book is the treatment of mechanical properties of materials under various types of static stresses coordinated with the analysis of stresses and design of simple machine and structural members. The correlation between stress



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Saze Units **place in position and securely hold together structural parts to be welded.**

As used in many welded structures they *eliminate all hole punching*, producing an economical, rigid, safe and quickly erected structural frame.

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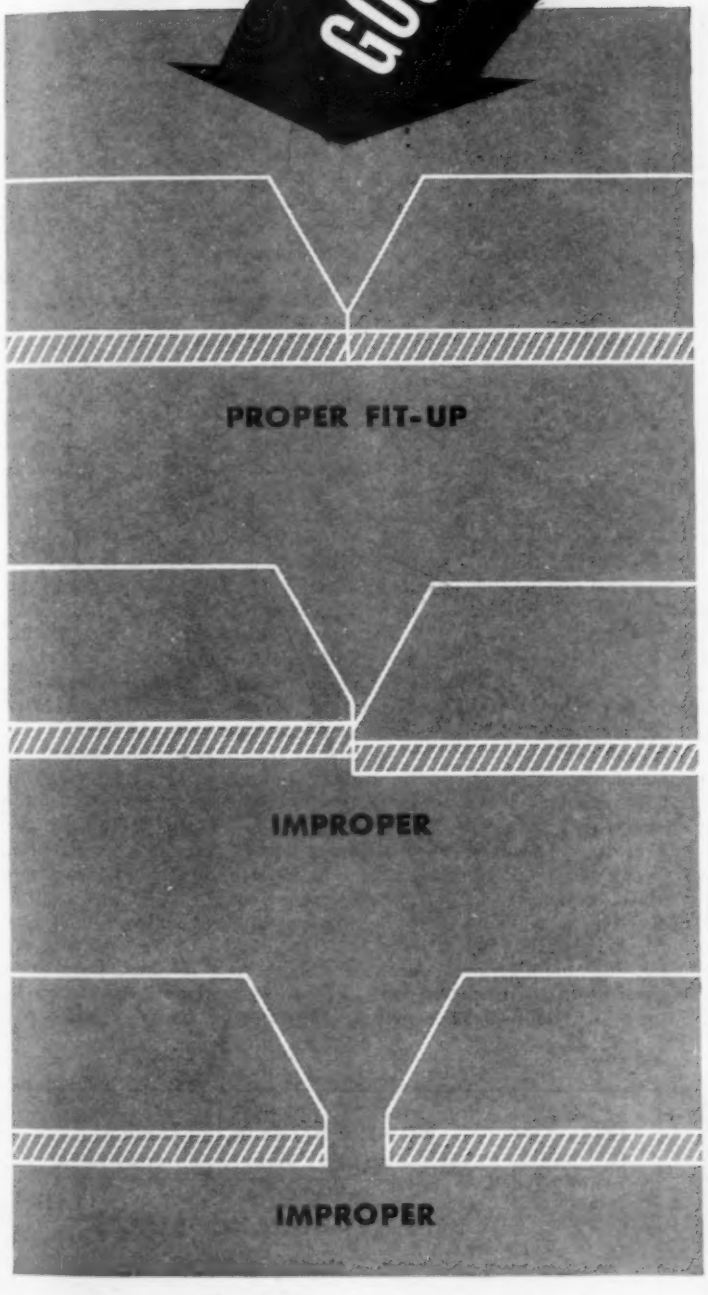

In welding clad steels, accurate alignment and fit-up of edges to be welded is an important step following preparation of plate edges. Care in this operation simplifies the welding work. It is then easier to make a joint having high structural strength and preserving the integrity of the corrosion-resistant clad surface.

After establishing the alignment of the clad edges, tack-weld on the steel side to hold it there. Use any good grade of carbon steel electrodes. Then lay down the root bead on the steel side, taking care not to penetrate the cladding.

Complete the weld on the steel side and then chip it back from the clad side until sound weld metal is uncovered. Finally, fill this in with rod matching the cladding. You will have an unbroken corrosion-resistant surface, providing the protection for which the Lukens Clad Steel was selected.

Clad steels are readily welded if the joint is properly designed and the correct procedure followed. For data on both, write Lukens Steel Company, 401 Lukens Building, Coatesville, Pennsylvania.

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STEELS

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analysis, mechanical properties and design is made possible by a discussion of mechanical properties at the end of each chapter. In this way, the student is better prepared to proceed with the study of machine, structural and aircraft design.

The arrangement of the material in four parts—Simple Stresses, Combined Stresses, Statically Indeterminate Stresses and Special Topics—is believed to give a more understandable treatment of the subject for undergraduate students.

BURDETT COMMEMORATES 25TH ANNIVERSARY WITH 28-PAGE BOOKLET

In celebration of its twenty-fifty year in business, the Burdett Oxygen Co., of Cleveland, has issued an elaborate booklet describing its history, products and service and showing pictures of its executives, personnel and offices.

Entitled "A Quarter of a Century of Service," the brochure tells how, on Feb. 17, 1923, William H. Loveman, President of Burdett, opened the doors of a small plant which occupied about 6000 sq. ft. of space. With five employees, an electrolytic Oxygen plant was put in operation that day.

"From that first day," the story continues, "Burdett grew steadily. In March, 1924, the first large Oxygen unit was installed. In 1927, a second Oxygen unit was added, and the distribution of Pyrolene was begun. Then, in 1931, the manufacture of Carbon Dioxide was added. And in June, 1937, a plant was built for the exclusive production of Acetylene. More Oxygen producing units were installed to meet growing demands.

"The famous line of Welding Machines and Equipment became a part of Burdett's industrial service in 1940. Then, a Burdett subsidiary—American Industrial Safety Equipment Company—was established in Brooklyn, New York, for the manufacture of safety equipment. In 1946, a handsome, modern store to provide welding equipment service to the Cleveland area was opened. Then, for the convenience of its customers in southern Ohio, Burdett opened a store, office and warehouse in Cincinnati. The latest expansion came in 1947 when The Burdett Oxygen Company of California was established in Los Angeles for the manufacture and distrubution of Oxygen and Acetylene and welding supplies.

"To adequately absorb these expanded facilities, manufacturing, warehousing and office space grew to a sprawling area of over 100,000 square feet. The employee list grew from the original 5 to over 200."

This history is concluded by pointing out that today, Burdett, and its trade name Burdox, is known around the globe as a complete source of welding and cutting equipment and supplies. It adds that Burdett distributors are located in every corner of the United States and in principal cities throughout the world.

Burdett's main plant is located at 3300 Lakeside Ave., Cleveland, Ohio.

GAILLARD OFFERS STANDARDIZATION SEMINAR, JUNE 21 TO 25, 1948

Because of the interest shown by industry in the private seminar on industrial standardization given early this year, Dr. John Gaillard, mechanical engineer on the staff of the American Standards Association and lecturer at Columbia University, has scheduled another five-day seminar Monday through Friday, June 21 to 25, 1948, in Room 503, Engineering Societies Bldg., 29 W. 39 St., New York City. Each of the two daily conferences, at 9:30 A.M. and 2:00 P.M., will consist of a lecture by Dr. Gaillard followed by round-table discussion. For an outline of the ten lectures and details about the registration, write to Dr. Gaillard at his home address, 400 W. 118 St., New York 27, N. Y., or phone him at A.S.A. headquarters, Murray Hill 3-3058.

The main purpose of the seminar is to assist those interested in the organization of company standardization work and the principles and technique of writing standard specifications. These problems are important to top management, as well as to standards engineers, designers, methods engineers, production men, inspectors, and quality control engineers.

The lectures will deal with the following subjects, in the order indicated: (1) Evolution of technical and managerial standards; (2) analysis of essential functions of standardization; (3) definition and characteristics of a standard; (4) standards and the general problem of quality control; (5) dimensional control; systems of fits; (6) limit gages and gaging inspection; (7) the four stages of standardization (from "company" to "international"); (8) organization of company standardization work; (9) simplification, unification and design of standards; use of preferred numbers; and (10) principles and technique of formulating industrial standards.

HEALTH OF ARC WELDERS

Hazards to the health of arc welders engaged in steel ship construction are negligible when adequate ventilation is provided to control the toxic fumes released, according to *Health of Arc Welders in Steel Ship Construction*, Public Health Bulletin No. 298, just released by the U. S. Health Service. The Bulletin reports a study of the health of shipyard welders which was made by the Industrial Hygiene Division, U. S. Public Health Service in cooperation with the U. S. Maritime Commission and the U. S. Navy in Maritime Commission and Navy-contract shipyards.

The study was initiated in 1943 because of increasing complaints of respiratory illness from shipyard workers. Although the study did not reveal any major health hazards, the findings will be of great assistance to physicians, engineers and compensation authorities.

The study included both environmental and medical surveys. During the environmental survey, analyses were made of the fume and gases contaminating the air of work places in seven Atlantic, Pacific and Gulf Coast shipyards. Some 1767 samples of iron and total fume were taken, 278 samples for zinc, 25 for lead and 2019 for the oxides of nitrogen.

In general, the concentrations of welding fume and gas observed were relatively low. Some type of control ventilation was available at all yards studied. Although the ventilation was of varying effectiveness, extreme degrees of atmospheric contamination were infrequent.

During the medical survey, 4650 persons (2950 men and 1700 women) were examined. Some 70% of these were shipyard arc welders who were working with coated electrodes on bare or galvanized

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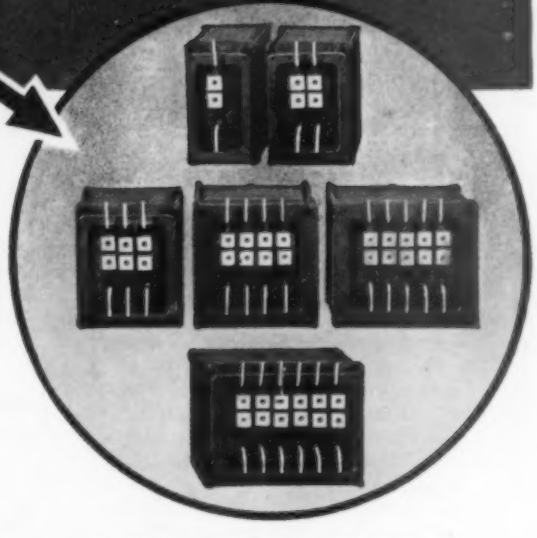

Typical 4-posted high-speed Martin hydraulically actuated 4-second cycle welding press shown here set up for welding automotive door panels. Easy change of dies converts quickly to other production runs.

·MARTIN· Modern production line timing demands versatility of welding presses. Interchangeable welding dies present numerous and complex welding patterns requiring a versatility of transformer design offered only by Martin. Current distribution is vastly simplified by the range of Martin standard multiple spot transformers. Another advantage accrues through the increased ability to balance load on a 3-phase supply system when machines are fired 3-phase. Let Martin quality and Martin experience go to work on *your* production lines.

Above are the Martin standardized 2, 4, 6, 8, 10, and 12-gun transformers which spell greater versatility. It's easy to see how easily the required selection of standard transformers to accommodate various welding patterns can be made and set up. Assuming a 48-spot pattern, four Martin 12-spot transformers would do the job. Chances are twelve ordinary 4-spots could not be accommodated in available space. Another example of Martin efficiency!

MANUFACTURERS OF QUALITY WELDING EQUIPMENT FOR 20 YEARS

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ELECTRIC COMPANY

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steel; about 21% were nonwelders who were included in the study for control purposes; and 9% could not be included in either group because of past exposure.

Only a few significant clinical symptoms which might be related to occupational exposures were observed among the workers examined. Among these were a respiratory symptom complex, arc welder's siderosis, lowered blood pressure and welding burns. Detailed studies failed to reveal any marked blood abnormalities among welders. There was no indication that welding fume, under conditions observed, predisposed workers to pulmonary tuberculosis. Gastrointestinal symptoms were infrequent.

The upper respiratory symptom complex noted occurred slightly more frequently among welders than nonwelders. Symptoms included pharyngitis, rhinitis, sinusitis and sometimes tracheobronchitis. These were usually mild and nondisabling and were productive of signs and symptoms indistinguishable in most respects from upper respiratory affections induced by allergic or other irritant toxic agents or by infections. Observations failed to reveal that welding fume irritated all welders, but suggested that the inflammations noted arose from infectious foci and other sources, and might have been aggravated by exposure to welding fume.

Arc welder's siderosis was diagnosed in only 61, or 3%, of the male welders and 10, or 3%, of the males who had mixed exposures. Inasmuch as iron oxide is the principal component of welding fume, it may seem surprising that so few welders showed this condition.

Since slightly lower blood pressure was observed among welders than among nonwelders it seems that factors associated with welding depress the blood pressure. The difference between welders and nonwelders was too small to make a clinical impression on the examining physician at the time of the individual examinations. Hence, no clinical laboratory tests were made to establish or identify the depressor or antipressor agents.

Welding burns or scars are intimately related to arc-welding operations. These lesions are only rarely disabling and usually can be prevented by adequate safety practices.

Single copies of *Health of Arc Welders in Steel Ship Construction*, Public Health Bulletin No. 298, by Waldemar C. Dreessen, Senior Surgeon; Hugh P. Brinton, Statistician; Robert G. Keenan, Senior Assistant Scientist (R); Thalbert H. Thomas, Sanitary Engineer (R); and Edwin H. Place, Surgeon (R) of the U. S. Public Health Service; and James E. Fuller, Lt. Comdr. H (S) USNR, Regional Health Consultant, U. S. Maritime Commission, may be obtained from the U. S. Public Health Service, Washington 25, D. C. Additional copies may be purchased from The Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 55 cents per copy.

GLENN-ROBERTS CO. APPOINTS CHIEF ENGINEER

Stephen B. Owings, former assistant supervisor of the welding electodes and equipment division of A. O. Smith Corp. of Milwaukee, has joined Glenn-Roberts Co. as assistant manager and chief engineer. Owings will make his headquarters at the Glenn-Roberts Co.'s Indianapolis plant, according to the announcement made by George G. Glenn, president of the firm.

A graduate in electrical engineering (University of Illinois, 1936), Owings has had 12 years of experience in the arc-welding industry. After receiving his degree, Owings joined the Harnischfeger Corp. in Milwaukee and spent four years in arc welder production, experimental engineering and sales work. In 1940, he became sales engineer for A. O. Smith Corp., and later was made assistant to the welding electrode and equipment division supervisor.

Mr. Owings is a member of the AMERICAN WELDING SOCIETY.

ALUMINUM SHEET & PLATE BOOKLET

One of the most complete technical helps in its field is the "Aluminum Sheet and Plate Booklet" just released by the Reynolds Metals Co., Louisville 1, Ky. The booklet, covering 48 pages of technical information relative to various sheet alloys, gages and sizes, was prepared to meet the steadily increasing demand for more information on aluminum sheet and plate and how to use it effectively.

Beginning with a brief discussion of cost factors, the booklet goes into a careful comparative analysis of costs of aluminum sheet and plate as against other widely used metals. This discussion along with a short outline of the advantages of using coiled or flat sheet does much to destroy the fallacy that aluminum must necessarily cost much more than other metals.

The booklet proceeds into short summaries of such topics as formability, weldability, riveting and joining, brazing, soldering, machinability, and resistance to chemical attack with a short discussion of the alloys most suitable. Also given is a short explanation of heat-treatable and nonheat-treatable alloys. Finishes for aluminum sheet and plate, characteristics of the metal, and the problem of avoiding distortion are likewise summarized briefly and a number of special items not previously shown in regular literature or information are listed in the booklet.

The mill standard sizes listing tabulates those sizes which Reynolds sheet and plate mills are equipped to produce. A section is used to list ordering data, while still other sections present tabular information on such topics as the specified chemical compositions, specified mechanical properties, typical mechanical properties, commercial tolerances and bend radii.

Since aluminum sheet and plate are sold by weight, a rather large section of the booklet contains tables for computing accurately the weight of various sizes and thicknesses of sheet and plate items. Also listed in the weight tables are figures for calculating the weights of a variety of sizes and thicknesses of aluminum circles. From these tables, the user is able to calculate closely the exact quantities his application will require. Also shown is a simple formula for comparing the weights of aluminum with the weights for other metals. Still other sections list a comparison of gages and decimal equivalents of aluminum sheet and plate gages.

One of the final sections of the booklet gives an index of specifications for aluminum sheet and plate as listed by the various government bureaus and a number of the nation's leading professional societies.

The 48-page 6- x 9-in. booklet is small and hence occupies a small amount of

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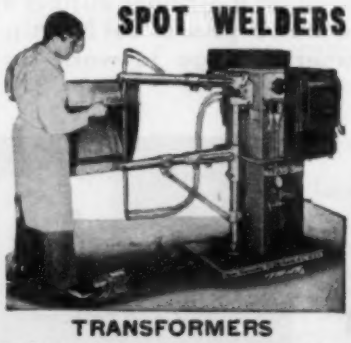

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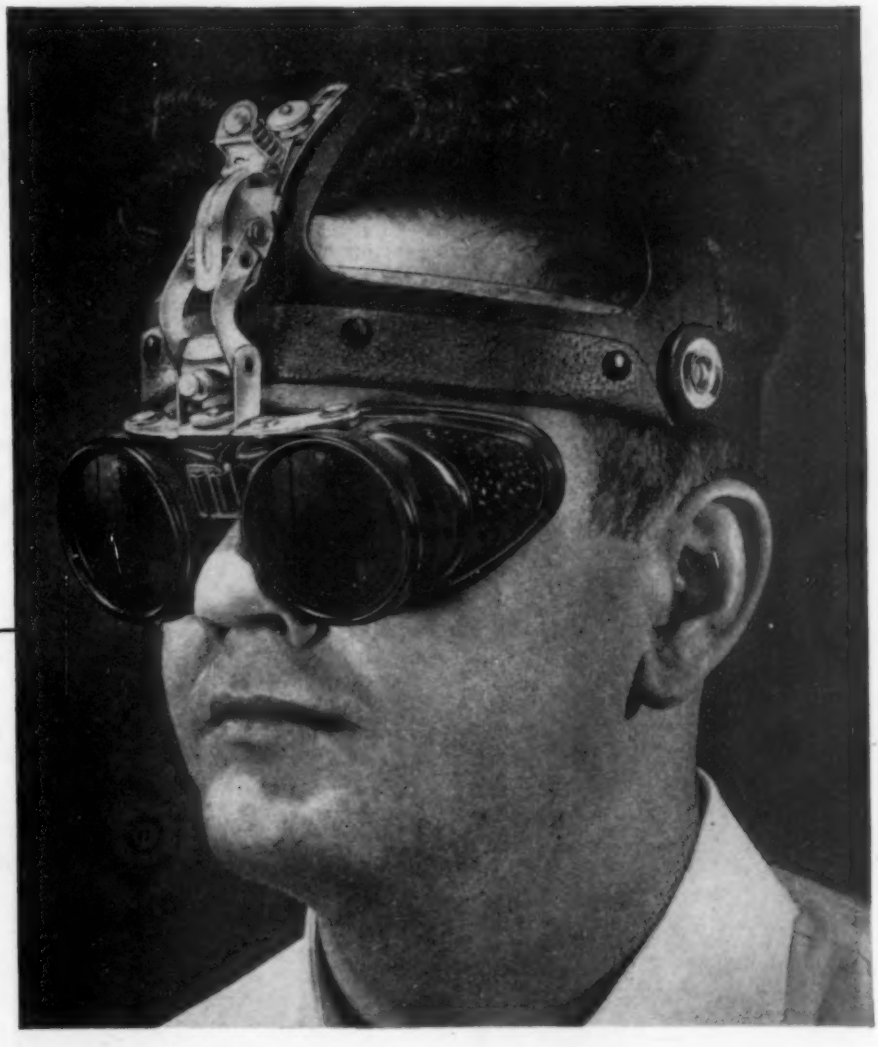

There's something NEW in glare, flying spark, scale and injurious light radiation PROTECTION for gas welders, cutters, burners, brazers and furnace men! It's the AO F-600 Headrest Goggle with an *entirely new and convenient spring mechanism.* Just a flick of the wrist and presto — the goggle's in the "off-guard" position! Due to perfect balance, there's no overhanging weight and the goggle feels comfortable even when "off-guard." Adjustment to wearer's facial contours and eyes can be quickly made and *no readjustment is required.*

The new F-600 Headrest Goggle may be worn directly over the eyes or over personal glasses. Comfortable-fitting fibre headgear adjusts to any head size . . . genuine leather sweatband is another comfort feature. Your AO Safety Representative can supply you with this goggle which is certain to be well-received by your workers.

FEATURES OF ADJUSTING MECHANISM

THUMBSCREW — Simply loosen to raise or lower goggle to correct position over eyes. Conversely, position is maintained by tightening screw.

PUPILLARY DISTANCE—Quick turn of center thumbscrew loosens bridge assembly, permits any width pupillary distance easily. Thumbscrew is permanently attached — can't be lost.

LOCK SCREW—Tighten when goggle is adjusted flush against face. Thus goggle maintains proper position despite constant throwing into "off-guard" position.

When these adjustments are made, they remain permanent for each individual face.

Safety Division of

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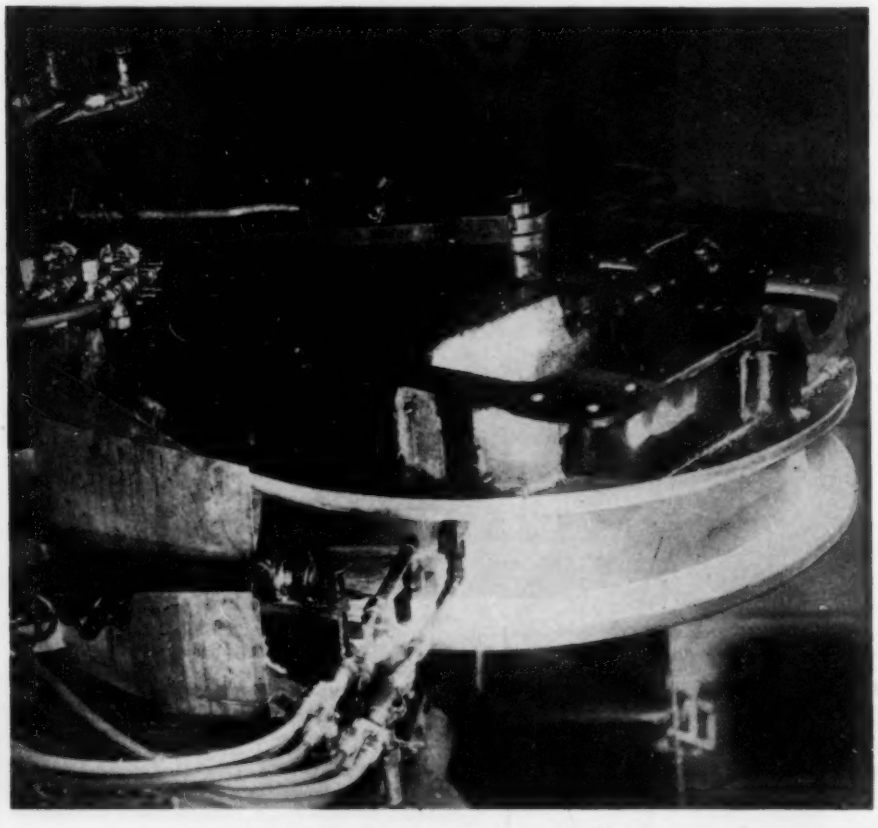
space on the desk or in the drawer, *or* can be easily carried in the brief case.

Requests for booklet should be directed to the Reynolds Metals Co., Aluminum Division, Desk 105, 2500 S. Third St., Louisville 1, Ky.

FLAME HARDENING

The Columbia Machinery and Engineering Corp., of Hamilton, Ohio, had the problem of hardening the roller pads of a lower frame casting used on power shovels. The extreme size and weight of the casting made it impractical to use existing hardening equipment. In cooperation with the Air Reduction Sales Co., they built a fixture for positioning and rotating the castings and for mounting the oxyacetylene torches and accessory equipment. The 3400-lb. casting was rotated at a speed of 7 in. per minute and the flame hardening operation was completed in 25 minutes. Two torches simultaneously flame hardened both the upper and lower faces of the roller rings to a depth of $^3/_{32}$ in.



Flame Hardening Casting

ALLOY AND WELDABILITY DIRECTORY

Condensation of a U. S. and Canadian engineering survey designed to show weldability of several thousand major and minor commercial alloys, as revealed by type of weld, equipment design and practical application of special gas and arc-welding rods, has been accomplished in an 8-page, 3-color technical directory recently made available for 1948 by Eutectic Welding Alloys Corp.

Welds are broadly classified by groupings of alloys and metals in widest use, together with lowest heat ranges permissible in welding for exact service requirements. Illustrations include microphotographs and sectional sketches for product, repair and design considerations of interest to engineering and welding supervisors generally. A short editorial indexes recent developments, including the arc-vapor cutting tool known as Cu Trode. Layout of the directory permits use in reference binders or wall chart form.

For further details, write direct to the manufacturer, at 40 Worth St., New York 13, N. Y. Ask for the 1948 Eutectic Welder Directory.

SCHUSTER MADE WELDING SUPERVISOR

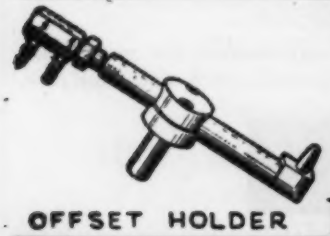
Announcement is made by American Car and Foundry Co. that William H. Schuster has been appointed Welding Supervisor for that company. Mr. Schuster comes to ACF with a wide and varied experience as a welding engineer.

William H. Schuster

A native of Pittsburgh, he attended the public schools of that city and later on Carnegie Institute of Technology. He further augmented his studies with special courses in welding with Westinghouse Electric Co. and The Lincoln Electric Co.; and in industrial relations and sales and job analysis work, acting as instructor in the latter subject.

He was first employed by Spang Chalfant & Co. as welder from 1931 to 1935 and the following year with the Bath Iron Works in the same capacity. He then went to The Lincoln Electric Co. as Welding Instructor and from 1937 to 1940 was Sales Engineer for that company. From 1940 to 1946 he was General Welding Supervisor for Cramp Shipbuilding Co. Prior to coming to ACF he was with Foster Wheeler Corp. as Welding Engineer.

Mr. Schuster is a member of the AMERICAN WELDING SOCIETY and is the author of "Arc Welding Instruction Manual" for shipyard welders, 1941. He will make his headquarters in New York.



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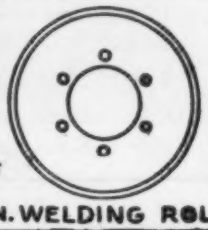
ELECTROLOY

Catalog and prices on request



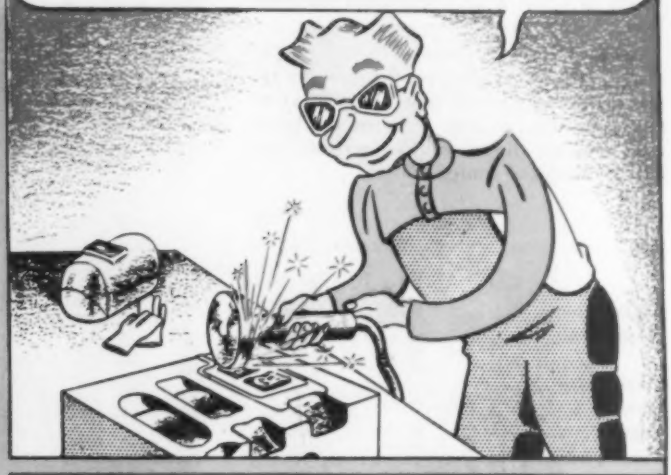
OFFSET HOLDER

THE ELECTROLOY CO. INC. 1600 SEAVIEW AVE. BRIDGEPORT, CONN. WELDING ROLL

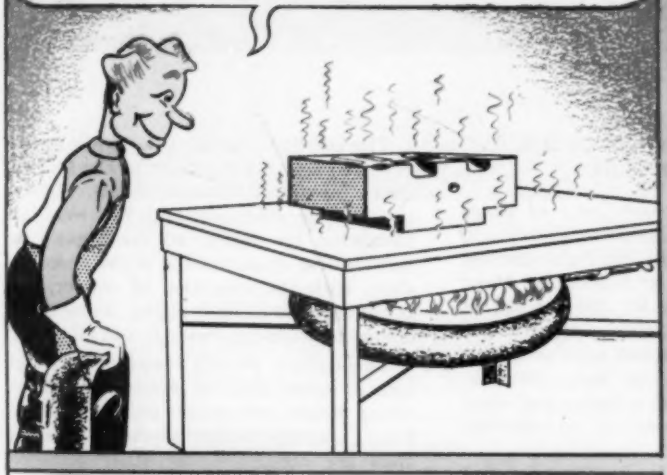
SPARKY Saves Production Delay

GEE, MISTER, THAT DIE BLOCK IS SHOT! LET ME SHOW YOU HOW I CAN FIX IT FAST WITH TOOL-ARC TOOL STEEL ELECTRODES.

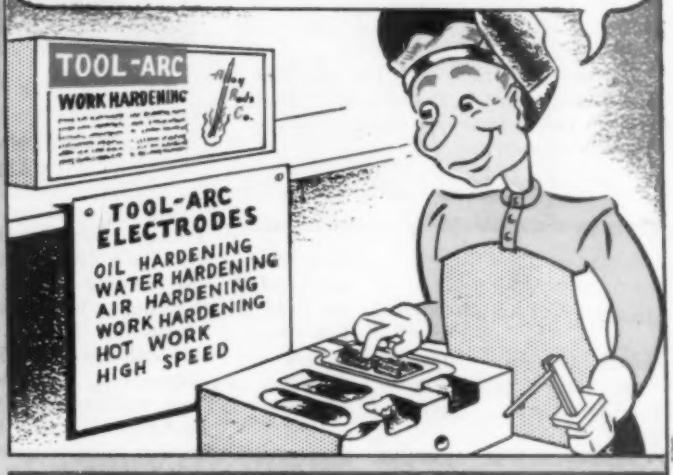
TOOL-ARC IS A LIFE SAVER FOR QUICK REPAIRS. FIRST, I GRIND THE DIE BLOCK TO PREPARE IT FOR WELDING.



NOW I PRE-HEAT THE DIE TO A MAXIMUM OF 450°, THE TOP DRAW RANGE TEMPERATURE, AND IT'S READY TO WELD.



THAT'S WHAT I CALL A PERFECT WELD! IT'S EASY WHEN YOU USE TOOL-ARC ELECTRODES – AND ECONOMICAL, TOO.



MACHINING TO SIZE "AS WELDED" IS A CINCH, TOO. THIS TOOL STEEL HARDENS WITH WORK. IT NEEDS NO HEAT TREATING.

RESINKING WOULD HAVE TAKEN WEEKS, BUT THIS DIE'S ON THE JOB AGAIN IN A FEW HOURS – THANKS TO TOOL-ARC.

For samples, see your distributor or write Alloy Rods Company, York, Pa.

NEW AMERICAN BUREAU OF SHIPPING SPECIFICATIONS

Structural Steel for Hulls

Chemical Composition—Ladle Analysis

(*a*) Except as specified in Paragraph (*b*) the material shall conform to the requirements of Class A as to chemical composition.

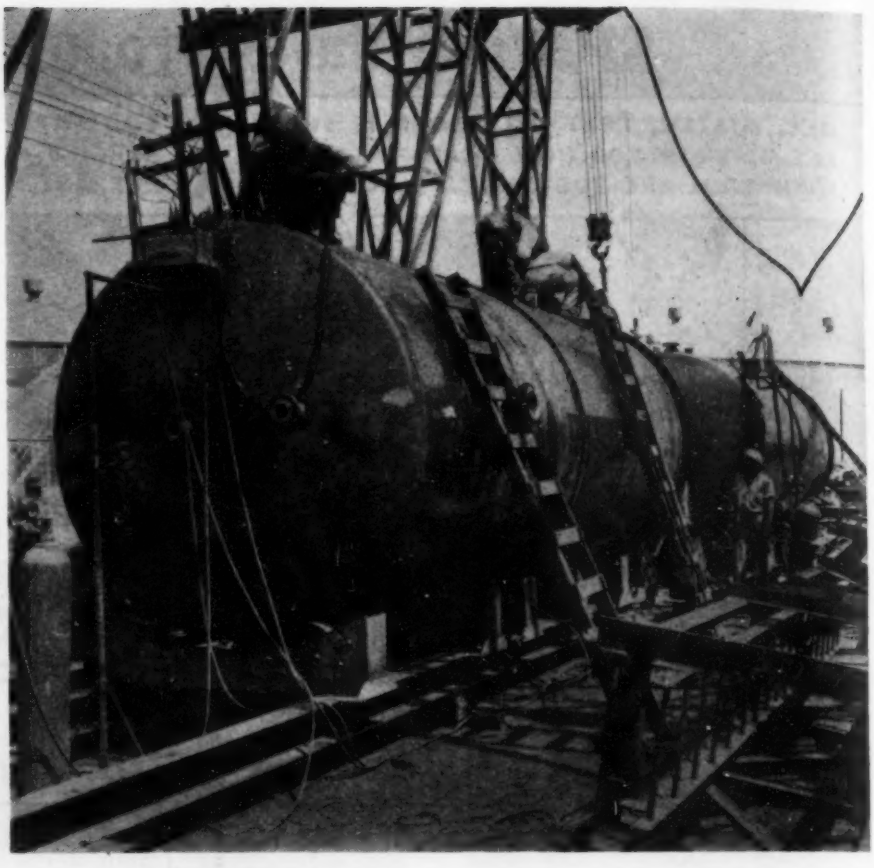
(*b*) Plates over 1/2 and up to 1 in., inclusive, in thickness shall conform to the requirements of Class B as to chemical composition. Plates over 1 in. in thickness shall conform to the requirements of Class C as to chemical composition.

	Class A	Class B	Class C*
Carbon, max. %	....	0.23	0.25
Manganese, %	....	0.60 to 0.90	0.60 to 0.90
Phosphorous, max. %	0.04	0.04	0.04
Sulphur, max. %	0.05	0.05	0.05
Silicon, %	....	....	0.15 to 0.30

*NOTE: Plate steels produced to the requirements of Class C shall be made with fine grain practice.

Tensile Properties. (*a*) The material, except as specified in Paragraph (*b*), shall conform to the following requirements as to tensile properties:

	Structural Steel	Rivet Steel and Steel for Cold Flanging
Tensile Strength, psi.	59,000–70,000	55,000–65,000
Yield Point, min., psi.	32,000	30,000
Elongation in 8 in. minimum, %	1,500,000 / T. S.	1,500,000 / T. S.
Elongation in 2 in. minimum, %	22	....



HELIARC WELDING OF CHEMICAL STORAGE TANKS

The Consolidated Steel Corp. of Texas reduced cleanup operations to a minimum by using the Heliarc inert-gas-shielded arc welding process in fabricating these Everdur alloy tanks for the storage of chemicals. High purity argon gas shielded the electrode and weld area thus eliminating the use of flux. Smooth, neat welds required no grinding and since flux was not used, there was no corrosive residue to be removed.

The tanks are 8 ft. in diameter and have an over-all length of 18 ft. with a 3-ft. steel skirt. Plate thicknesses were 3/16 in. for the shell and 1/4 in. for the head.

The inert-gas-shielded arc welding process has made rapid strides in the fabrication of nearly all types of metals. In this process the electrode and the weld are blanketed by argon, an inert gas. An outstanding characteristic of the process is that, with the exception of copper, flux is not required in the welding of any of the common commercial metals and alloys.

The Heliarc process operates at a high rate of speed and, in addition, produces sound welds with much greater freedom from porosity and hot-short cracking than are obtainable by other methods. The fast rate of welding causes less distortion in the workpiece and reduces the over-all cost.

WELDING RODS

Gas or electric, various sizes, your favorite rod: Shieldarc, Fleetweld, General Electric, National, and other various steels, 6¢ lb.; Airco 27 bronze 25¢ lb.; Inco Nickel and Monel 40¢ lb.; Phillips 60 phos bronze 30¢ lb.; Arcos, Smith, Crucible Steel Allegheny and other Stainless Steels 25¢ lb; hard face rod 50¢; copper 25¢; aluminum 30¢; pure 1/8" tin wire 80¢ lb., also other metallizing wires; Fluxine, Eutectic and other fluxes 25¢ lb.; Welding goggles 50¢; Manifold regulators $25; 150 and 300 Amp Welders with 3 phase motors $200 and $325; Electric hand drills 1/4" to 1" Thor, Skillsaw, B & D. $10 to $75; motors and grinding stones; from government surplus. Satisfaction guaranteed. Prices F.O.B. Oak Ridge. Du Pont Smith, Box 74, Oak Ridge, Tenn.

NET MONTHLY ADVERTISING RATES

Black and White — *Effective July 11, 1947*

Space	One Insertion	Three Insertions	Six Insertions	Twelve Insertions
*Full page	$185	$165	$150	$140
Two-thirds page	130	120	110	100
Half Page	105	95	85	80
Quarter Page	60	58	55	50
Eighth Page	40	35	30	28
*Inside Preferred	205	185	170	160

10% Extra for bleed full pages. Color $65 extra per color added

Agency Commission —15%
Cash Discount — 2%, 10 days

Faster A. C. Welding for More Jobs with Proper Equipment

Fabricating a truck frame for an 11-yd. Euclid Rear Dump Truck with one of the 500-amp. "Fleetwelders" at Euclid Road Machinery Company.

USERS of the New Lincoln "Fleetwelder" report that it has extended the high-speed advantage of AC arc welding to a wider variety of work. A combination of two features—an Independent Control Circuit and an "Arc Booster"—accounts for faster, easier welding over an exceptionally wide range of output.

Setting "Fleetwelder's" current control is simply a matter of turning a hand wheel. These welders operate three shifts at 450 amps. for 5/16" electrode.

ARC IS MORE PRODUCTIVE. Higher responsiveness to changing arc conditions has been secured by a Reactor Control Circuit which is separate from the main welding circuit. This gives a smoother arc and higher welding speed at all current values. By simply turning a hand wheel, the operator rotates the reactor control and this provides smooth, stepless, accurate adjustment of the welding current over the entire range of the welder. The amperage is indicated on a dial on the front of the welder.

SIMPLIFIES ARC STRIKING. The "Arc Booster" starts the arc automatically by giving it a momentary burst of current the instant the electrode touches the work. A "Job Selector" switch provides six stages of booster intensity to suit the job.

FOR HEAVY WORK, the "Arc Booster" gives a quicker "get-away" and assures deeper penetration at the start of the bead. And the welder can be operated at high current values for sustained periods without danger of burn-out because its windings are protected by a thermostatic device.

FOR LIGHT WORK, the "Arc Booster" makes arc striking as easy as lighting a match, even at exceptionally low current values, and the highly sensitive Independent Control Circuit helps keep the welding arc smooth at all times.

The above is published by LINCOLN ELECTRIC in the interests of progress. For full details on the new "Fleetwelders" write for copy of Bul. 366. The Lincoln Electric Company, Dept. 105, Cleveland 1, Ohio.

Advertisement

TAYLOR MADE by TAYLOR-WINFIELD

wheel housing seam welded in 15 seconds (RESISTANCE)

PRODUCT—Rear wheel housing for a new automobile design.

PROBLEM—To weld housing from stamped halves in one-half the time required with conventional or standard seam welder. Material is 20 ga. cold rolled steel.

TYPE OF WELDER—Special series T-W seam welder with dual, roller anti-friction heads and special air operated pivoting fixture.

PROCEDURE—Halves of wheel housing are placed in fixture. Following sequence is fully automatic. One operation of palm button sets up this cycle...(1) clamps work; (2) moves fixture to welding position; (3) brings welding heads down and heat on, as fixture starts to rotate. On completion of weld, fixture automatically returns to unloading and loading position and unclamps completed assembly.

COMMENT—This special seam welder is designed to fabricate wheel housings of such depth and shape as could not be economically or efficiently deep drawn from one piece to like dimensions.

RESULTS—A production of 150 complete wheel housings per hour with an average welding time of 15 seconds per assembly.

Our monthly publication "Weld-It" shows many production short cuts by resistance welding. Request it using your company letterhead.

THE TAYLOR-WINFIELD CORPORATION
WARREN, OHIO, U. S. A.

TAYLOR-WINFIELD
RESISTANCE WELDERS

DUTTON ELECTED VICE-PRESIDENT

Frederick O. Dutton has been elected vice-president in charge of production for Process Engineering, Inc., of Somerville, Mass., according to an announcement by Lawrence C. Paul, president of the company. He assumed his duties on Jan. 1, 1948.

Mr. Paul stated that Mr. Dutton comes to Process Engineering from Union Carbide & Carbon Corp., with whom he was associated for the past twenty-five years. He acted in various capacities for The Linde Air Products Co. and Carbide & Carbon Chemicals Corp., the last of which was as Chief Inspector.

Mr. Dutton comes to Process Engineering with a wealth of experience covering the design and welding of fabricated equipment. He is widely known in the fabricating industry. He is a member of the American Society of Mechanical Engineers, the AMERICAN WELDING SOCIETY and a registered engineer in the state of West Virginia.

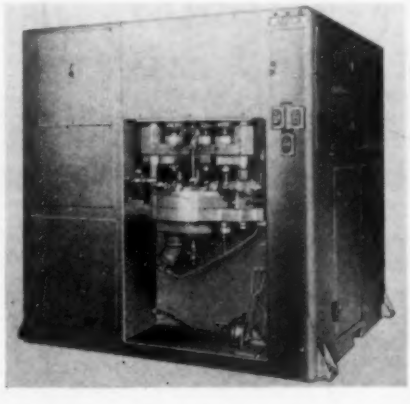
STUD WELDING

A four-page house organ issued bimonthly is now published describing the Nelson Method of fastening for design engineers, production management executives, architects, general contractors and those at the top industrial management level. This method of fastening incorporates the use of the Nelson Stud Welding Gun which end-welds various types of stud-like fasteners to steel framing. The gun is a lightweight portable unit and weld studs from 1/8 through 3/4 in. diameter up to 9 in. long in any position. The outstanding advantage of this method is that it provides a neater, better fastening job and, in numerous instances, radically reduces costs. It eliminates the necessity of drilling and tapping holes for stud fastening and provides for all the work to be done from one side. The house organ describes various applications where cost savings were accomplished, or where the design and appearance of the finished prod-

uct were substantially improved. Published by the Nelson Sales Corp., Toledo Ave. & E. 28th St., Lorain, Ohio.

ASSEMBLYING PRESS FOR WELDING OPERATIONS

A special hydraulic machine for assembly of one-piece spark plugs that can also be adapted to progressive welding and forming operations is announced by Agnew Electric Co., Milford, Mich. It is identified as Special Hydraulic Machine, Type HCP3-5. All sequencing operations are performed hydraulically providing against any possibility of machine getting out of proper sequence. This machine incorporates a table that has six stations which index 60° by means of an hydraulic motor. Speed of deceleration and acceleration of indexing is adjustable by means of a flow valve through infinite steps. Individual pressure adjustment for each of the three rams is provided. Pressures up to 8 tons are obtainable; individual adjustable cushioned stroke. Foot control—machine operates as long as control is depressed. At any time foot pedal is released all three rams immediately return to their up position and machine stops. Cross heads have replaceable bushings and operate on hardened and ground large diameter guides. Two are provided for each cross head. Sturdy fabricated frame with oil tank in base with cover plates for inspection of pump, filters, etc., which are all located in oil tank and enclosed. All hydraulic controls isolated from electrical components and conveniently grouped for easy adjustment. Automatic oil temperature control to maintain proper operating temperature of hydraulic oil, valves, etc. Double-volume pump to provide fast speed of rams and pressures up to 1000 psi. is driven by 15 hp. motor. Water cooling to dies, punches, transformer, punch holder, etc. Electrical controls readily adjustable at front of machine. Electronic control of heat and pressure functions. Flush mounted disconnect switches used. Weight of machine, 10,000 lb.; floor space, 60 x 60 x 60 in. high; speed of machine, 1500 complete parts per hour.



WIRED FOR SPEED

MORE WELDS PER MAN-HOUR
MORE SAVINGS FOR YOU!

1 Thousands of twisted wires properly shaped provide extra-flexibility. Less tiring for worker to handle.
2 Tough construction offers greater resistance to abrasion, oil and water. Less time out for repair.
3 Bright copper wires of hair width-sizes provide high conductivity. Steadier power on the job.
4 Heavy live rubber jacket and heavy tape wrapping protect wires. Prevent "shorts" and breakdowns.

BURDOX
EXTRA-FLEX welding cable

"4 FEATURE" Extra-Flex Cable gives you more welds . . . better welds per man-hour because it works with the man-on-the-job. With its many exclusive production advantages, it costs you far less than you would expect to pay for cable of this high quality. Next time you order cable specify "Extra-Flex"! Immediately available in sizes from 6 to 4/0 from your welding supply distributor. If he cannot supply you, write direct.

Send for new free 64-page catalog of latest type welding and cutting equipment.

THE BURDETT OXYGEN CO.
3328 Lakeside Ave. • Cleveland 14, Ohio
Welding and Cutting Equipment and Supplies
Industrial Safety Equipment

The Burdett Oxygen Co.
3328 Lakeside Ave., Cleveland, O.
☐ Please send copy of free 64-page catalog.
Name .....
Company .....
Address .....
City & State .....

USE THIS ONE
SOURCE OF SUPPLY
Save time . . . money . . . save shipping costs by ordering all your welding and cutting needs from one source—BURDOX —known for quality since 1920.

WELDING EQUIPMENT
CUTTING EQUIPMENT
PROTECTIVE EQUIPMENT
ACETYLENE GENERATOR

TENTATIVE PROGRAM

AMERICAN WELDING SOCIETY
TWENTY-NINTH ANNUAL MEETING
WEEK OF OCTOBER 24, 1948

BELLEVUE-STRATFORD HOTEL, PHILADELPHIA, PA.

WELDING AND CUTTING EXHIBITS AND DEMONSTRATIONS

NATIONAL METAL EXPOSITION

COMMERCIAL MUSEUM AND CONVENTION HALLS

HOURS OF THE EXPOSITION

Monday, Tuesday and Wednesday—October 25 to 27
12 Noon to 10:30 P.M.

Thursday and Friday—October 28 and 29
10:00 A.M. to 6:00 P.M.

Admission by special invitation or by A.W.S. registration badge or membership card of any participating Technical Society.

TECHNICAL SESSIONS

All Technical Sessions will positively start on time.

No Stenotype Reporter—Members desiring to discuss papers are urgently requested to prepare discussion in writing in advance of the meeting and to send copies to Headquarters, as those preparing written discussion will be given preference at the session. Members and guests giving extemporaneous discussion at meeting should forward a written discussion as soon as possible after the meeting.

PRESIDENT'S RECEPTION
SUNDAY, OCTOBER 24th, 5 to 7 P.M.
Burgundy Room

MONDAY, OCTOBER 25th, Morning—9:30 A.M.
THREE SIMULTANEOUS SESSIONS

SHIP DESIGN
South Garden

Chairman—H. W. PIERCE, New York Shipbuilding Corp.

Co-Chairman—R. L. DEILY, Bethlehem Steel Co.

New Factors to Be Considered in the Design and Welding of Ships
by MILTON FORMAN, United Engineering Co.

Riveted vs. Welded Structure
by E. M. MacCUTCHEON, David Taylor Model Basin

Repair of Welded Ships
by L. E. BLEDSOE, Newport News Shipbuilding & Drydock Co.

RAILROAD
North Garden

Chairman—J. W. SHEFFER, American Car & Foundry Co.

Co-Chairman—A. J. RAYMO, The Baldwin Locomotive Works

Submerged-Arc Welding of Box and Hopper Cars
by E. A. WATSON, American Car & Foundry Co.

Welding the Modern Diesel Locomotive
by H. S. SWAN, American Locomotive Company

General Welding Practices in Locomotive and Car Shops
by J. MICHNE, New York Central System

STORAGE TANKS, PRESSURE VESSELS & PIPING
Rose Garden

Chairman—A. C. WEIGEL, Combustion Engineering Co.

Co-Chairman—E. B. STOLLE, Midwest Piping & Supply Co.

Field Erected Storage Tanks of Aluminum
by FRED L. PLUMMER, Hammond Iron Works

Standardization of Welded Chemical Process Tanks
by J. G. HENDERSON, Carbide and Carbon Chemicals Corp.

Sampling of Welds by Trepanning and Allied Methods
by R. B. LINCOLN, Pittsburgh Testing Laboratory

Pipe Welding
by JOHN H. ZINK, Heat & Power Corp.

FREE SAMPLES OF NI-ROD WELDING ELECTRODES

LEARN FOR YOURSELF WHY WELDERS CALL NI-ROD "THE EASIEST-HANDLING ELECTRODE EVER MADE TO WELD CAST IRON"

WHY WE MAKE THIS OFFER

In 1945, after several years of development and thousands of tests, The International Nickel Company introduced Ni-Rod* welding electrodes.

At that time we thought our laboratories had produced a rod that would finally take cast iron welding out of the "hit-or-miss" class.

Today, Ni-Rod has proved even better in the field than it did in the original tests.

Sales records show that 82% of our customers re-order Ni-Rod once they try it!

Welders keep telling us that Ni-Rod is the easiest-handling electrode ever made for welding cast iron.

And they're not only using Ni-Rod to weld cast iron. They're also using Ni-Rod to weld cast iron to steel.

Our files are filled with letters saying nice things about Ni-Rod. We doubt if any other welding rod has ever been welcomed more enthusiastically.

Now, to make sure that *every* welder has the pleasure of trying Ni-Rod, we're offering three free rods of any one diameter you select. Just fill in the coupon below.

*Reg. U. S. Pat. Off.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET, NEW YORK 5, N. Y.

Here's What NI-ROD Gives You

in Performance

- Stable arc in all positions
- Smooth bead contour
- Excellent "wash"
- Easy slag removal
- Preheating seldom required
- Works on either a.c. or d.c.

in Weld Quality

- High-strength deposit
- Easy machinability
- Thorough fusion
- Freedom from cracks and porosity
- Close color match

in Usefulness

- General repair and maintenance of cast iron parts, including the building up of worn surfaces
- To remedy minor flaws in new castings
- For correction of machining errors
- As a production tool to assemble cast iron to steel

EMBLEM OF SERVICE
INCO NI-ROD
TRADE MARK

SEND IN COUPON TODAY!

Mail your coupon right away. When you get your three free electrodes try them on any cast iron job in the shop. We feel sure that you, too, will say, *"Ni-Rod is the last word for welding cast iron."*

Ni-Rod comes in 3/32", 1/8", 5/32" and 3/16" diameters. Please check the size you want on the coupon below.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Gentlemen: I'd like to try Ni-Rod welding electrodes. Please send me 3 free rods of the diameter I have checked.

☐ 3/32" ☐ 1/8" ☐ 5/32" ☐ 3/16"

(Please check *one* size only)

Name.....

Company.....

W.J. 5-48

Address.....

City.....*State*.....

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this section

STAINLESS STEEL ELECTRODES

Twenty-seven new Flexarc stainless steel electrodes covering the complete range of types and diameters ($^1/_{16}$, $^5/_{64}$, $^3/_{32}$, $^1/_8$, $^5/_{32}$, $^3/_{16}$ and $^1/_4$ in.) required for all commercial grades of chromium, nickel and straight chromium steels are available from Westinghouse Electric Corp.

These electrodes are produced in two popular types: a combination Titania-Lime type coating suitable for welding with a.-c. and d.-c. reverse polarity; and a straight lime type coating for welding with d.-c. reverse polarity only.

Each of these types is suitable for welding in all positions in diameters $^3/_{16}$ in. and below and each meets the requirements of the new A.W.S. designation A 5.4–46 T, A.S.T.M. designation A 298–46 T tentative specifications for chromium and chromium-nickel steel welding electrodes where applicable.

Characteristics of these stainless steel electrodes are the fine smooth bean finish with relatively flat contour, smooth action with extremely low spatter loss, and excellent slag characteristics resulting in correct bead formation and easy cleaning.

Further information on the Flexarc line of stainless steel electrodes may be secured from the Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

RUF-TRED TOOL

The Ruf-Tred tool provides a simple low-cost method of preventing slipping and falling accidents on smooth steel or iron surfaces. It is a vibrating electrode holder used with either a.-c. or d.-c. welding machines to deposit hard rough bead lines about $^1/_8$ in. wide and $^1/_{16}$ in. high. On a large area, the bead lines are usually spaced several inches apart and are arranged in a geometrical pattern such as diamonds. On a small area like the nosing of a stair tread, several closely spaced parallel bead lines are usually deposited.

In operation, the end of the electrode is placed in contact with the surface to be roughened and drawn along at approximately 5 feet a minute. It is not necessary to "hold" an arc, as in welding, since the vibrator causes intermittent arcing, which melts the end of the hard steel electrode and fuses the molten droplets to the base. The deposited metal is extremely hard and retains its slip-proof qualities, even when wet or oily.

Metallizing Engineering Co., Inc., Safety Products Div., Long Island City 1, N. Y.

SYNTHETIC HOSE

Dependability and life have been greatly extended in the flexible tubing field as the result of an extensive research program conducted by engineers of the Ronaflex Tubing Co., Inc., Packard Building, Philadelphia 2, Pa. These improvements are the result of new Buna and Neoprene base synthetics which stand up under the terrific punishment of high temperatures, pressures, vibration, internal and external corrosive solvents and fumes. Not only is useful life increased many times, but leakage and maintenance troubles are eliminated.

Synthetic Hose Carrying Air at 80 Psi.

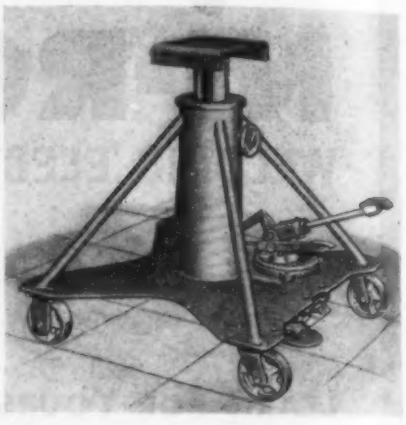
The Ronaflex Assembly illustrated is carrying air at 80 psi. Although constantly soaked by process oil, grease and grime, tests indicate that this wire-braid Ronaflex has already served four times as long as those previously used and shows no sign of failure. One-quarter inch tubing will stand burst pressures to 1000 psi. and larger sizes proportionally less. Installations for temperatures to 300° F. are not uncommon.

The patented, rugged, light weight couplings, provided with standard Ronaflex assemblies, snap on or off in a second to save maintenance time, yet provide a tight positive grip that eliminates all trouble due to leaking joints. No packing is necessary, no tightening required.

Standard sizes from $^1/_4$ to 2 in. I.D. and in a complete range of lengths up to 200 ft. in the small diameter and 50 ft. in the largest diameters are supplied and shipped within 72 hr. of the time an order is received.

HYDRAULIC TABLE AVAILABLE WITHOUT TOP

For special applications requiring an adjustable pedestal capable of handling 2000-lb. loads, Lyon-Raymond Corp. offers its standard hydraulic elevating table without the regular top. An 8- x 10-in. bracket is furnished for mounting special tools and fixtures.



The platform elevates from 28 to 44 in. It can be locked in one position or allowed to revolve freely.

A 30- x 30-in. base provides ample stability even for off-center loads while two 5-in. swivel casters and two 5-in. rigid casters make it easy to move about. A floor lock will hold the table firmly positioned when required.

Elevation is provided by a hydraulic cylinder and single-speed hydraulic foot pump with pedal release.

Further information may be obtained by writing to Lyon-Raymond Corp., 4900 Madison St., Greene, N. Y.

ARC METAL-CUTTING TOOL

Applications of the novel low-cost surface and underwater metal-cutting tool that employs electric arc vapor, known as "CutTrode" are shown in a new illustrated 8-page bulletin published by Eutectic Welding Alloys Corp.

Complete information, technical diagrams, instructions for using "CutTrode" for large industries and smaller shops are given in detail. Operating hints outlined will aid all metal working men, whether for repair or production metal cutting.

For construction welders, maintenance men, riggers, specialists in implement repairs, rescue workers, salvage operations, shipbuilders, etc., this bulletin will prove especially interesting. Illustrations show "CutTrode" at work piercing, cutting, gouging, chamfering on cast iron, stainless steel, aluminum and other metals considered difficult to cut by conventional methods.

In addition, the bulletin contains application information for several popular welding rods, including those recommended for latest type of "threadless" pipe fittings and a selective welding chart for judicious rod and alloy selection by welding engineers and supervisors.

Ask for the "CutTrode Issue" by writing the manufacturer at 40 Worth St., New York 13, N. Y.

IMPROVED HANDLE SCREW

Experience in making thumb screws and other types of adjusting screws has indicated a need for an improved and cheaper handle screw that would have a grip or handle leverage greater than that available with conventional forged and cast screws.

To satisfy that need, the Ohio Nut & Bolt Co., 600 Front St., Berea, Ohio, are bringing out the Ohio Double-ball Handle Screw. In the production this of screw on modern projection welding machines of the press-type, the company is utilizing the most advanced practice in electronic controls. The electronic control of the welding process makes possible a welded joint of greater strength than the metal in either of the parts that are welded together. Among the industries that can improve the appearance of their product and at the same time reduce the cost of an important component are those manufacturing bass drums and other musical instruments of the percussion type; food choppers for domestic use; outboard motors; and demountable steel scaffolding.

NEW TYPE AUTOMATIC ACETYLENE TORCH

Pictured below is an automatic acetylene torch of novel design, produced by Century Aircraft Co., 5601 W. Century Blvd., Los Angeles 43, Calif. It is called the Century Gas Gun. This type of acetylene torch with pistol grip and trigger operated lighting mechanism was developed by Century during the war years and was used extensively for speeding up soldering, brazing and lead burning operations in war plants. Since the war, the gun has been completely redesigned and the manufacturer claims the following advantages for the new model: (1) The automatic lighting and extinguishing feature saves time and prevents wasting of gas; (2) the light weight of the gun (12 oz.) and convenient pistol grip make it easier to handle; (3) the gun is safer to operate because the flame is never left burning when not in use; (4) interchangeable combustion tubes, nozzles and extension tips provide a range of flame sizes to handle all types of work.

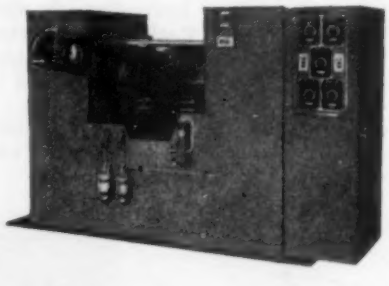
The Gas Gun is designed to operate only with acetylene gas. It is ordinarily used with MC- or B-type acetylene tanks for soldering of joints, sweating in of copper fittings, light brazing or lead burning. The gun is sold through plumbing, electrical and welding supply houses

complete with the following accessories: pressure gage and regulator, connecting hose and clamps, combustion tubes and nozzles in $^1/_8$, $^3/_{16}$ and $^1/_4$ in. sizes and 45° angle extension tips in $^3/_{16}$ and $^1/_4$ in. sizes for use where brazing or soldering must be done in places difficult to reach.

John Henry, General Manager of Century Aircraft Co., states that thousands of Century Gas Guns are now in use throughout the country in the plumbing, electrical and automotive trades.

MULTIPLE WELDER SPEEDS TOY WHEEL ASSEMBLY

Designed and built by Sciaky Brothers Inc., Chicago, the machine is actually two welders mounted opposing each other —each with a set of eight opposing electrodes. Each unit houses two transformers, and full electronic controls are mounted in a cabinet at one end. A gravity feed chute passes through the center of the machine. The operator has only to keep the chute full... wheels drop into welding position and automatically initiate pressure cylinders and welding current.



Overload on the power supply is avoided by dividing the complete weld into two firings. When the cycle is completed, electrodes retract and the welded part continues to roll on the chute, then drops on a belt which loads into a bin. The next wheel drops into place and the cycle is repeated.

High-speed action of the electrodes completes wheels (each takes eight welds) at the rate of 30 per minute. Electrodes and integral pressure units can be adjusted or reduced in number to accommodate wheels of different sizes.

The wheel is made of two stamped halves, held together before welding with a flanged bearing shaft. This high-speed method of fabrication suggests many other applications, such as pulley wheels, break drums, etc.

PHOTOELECTRIC RECORDING WATTMETER

A new photoelectric recording wattmeter designed for such applications as analyzing welding circuits and measuring industrial heating load, motor-starting load, and power surge has been announced by the Meter and Instrument Divisions of the General Electric Co. Consisting of a high-speed photoelectric recorder and a newly designed wattmeter measuring unit, the new instrument can be used to measure d.-c. power or a.-c. power up to 10,000 cycles per second.

The wattmeter, which has a linear scale, is available for portable use or for semi-flush mounting. Chart speeds of $^1/_2$ in. per hour up to 72 in. per minute can be obtained by using different combinations of chart carriages and rate gears. When the instrument is calibrated for a particular frequency, accuracy is ±3%. When calibrated for 60 cycles, it can be used over the entire range of from 60 to 10,000 cycles at unity power factor with an error of ±5%. The power-factor error when going from 0.5 lagging to 0.5 leading is only ±3%.

The current circuit is rated either 5 or 10 amp., and the potential circuit either 120 or 240 volts. Current and potential transformers can be used to extend this range if necessary. The wattmeter is compensated for frequency and power-factor changes. It is critically damped, and its burden is low because of the use of special magnetic materials.

ELECTRODE FOR CAST IRON

Machinable electric welds at amperages in the 45–140 range can now be made on cast iron with a new electrode just announced by All-State Welding Alloys Co., Inc., 96 West Post Road, White Plains, N. Y. This electrode has a nickel core and is highly recommended for use on cast iron wherever free machinability and perfect color match are required. One of its out-

standing features is its freedom from spatter. On certain castings it has a greater affinity for the parent metal than a copper-nickel electrode. It is especially recommended for the repair of cylinder heads and motor blocks because of the low amperage required and the ductility that is obtained in the weld. This electrode, known as All-State No. 4 Fully Machinable Cast Iron Electrode, can be used on either a.-c. or d.-c. and is obtainable in diameters of $^3/_{32}$-, $^1/_8$- and $^5/_{32}$-in.

SHAPE-WELDING MACHINE

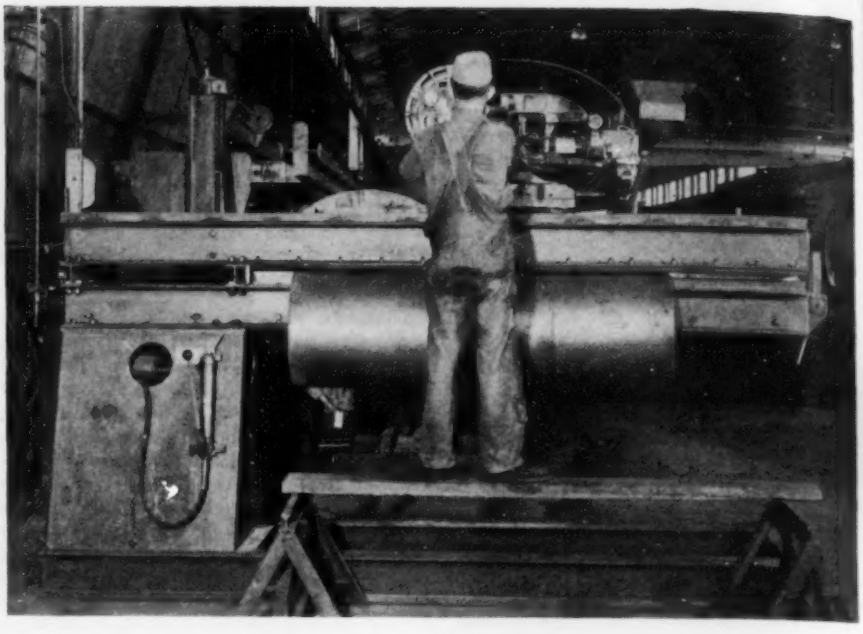
A new machine for making welds to any outline by its submerged-melt welding process has been announced by The Linde Air Products Co., Unit of Union Carbide and Carbon Corp.

The WM-6 machine, a carriage of the type that has proved most useful in oxy-acetylene shape cutting, is used to carry and guide a Unionmelt welding head. Any desired outline can be followed by use of a strip templet.

The Type U welding head illustrated has a maximum current capacity of 2000 amp. and can weld in a single pass material from 18-gage to $1^1/_4$-in. plate. Heavier parts of almost any thickness can be welded by a suitable number of passes.

The machine will operate over an area 34 in. wide and 80 in. long. Sections can be added to the tracing table so that any length can be covered. The welding speed is adjusted by a stepless speed control on the tracing machine. Standard or high-speed tracing heads make it possible to weld at speeds of from 4 to 40, or 11 to 100 in. per minute.

The machine has already been used in several plants for welding special shapes. An example of this type of work is the welding of ends to shells of domestic fuel oil tanks (Fig. 2). This machine will be particularly useful in fully mechanizing the welding of certain intricately shaped parts that heretofore could only be welded manually.



SEAM WELDER

The Reed Engineering Co., 1003–17 W. Fairview Ave., Carthage, Mo., have recently developed and placed on the market a new machine. This is known as the Reed Longitudinal Seam Welder. The prime purpose of this machine is to provide a positive copper backup for automatically welding longitudinal seams in tanks and other cylindrical shapes. The copper backup bar is forced upward against the copper hold down clamps by means of an air-operated toggle linkage which exerts sufficient pressure to press the seam flat and back up the edges during the welding operation. It is available in 6 standard sizes, ranging from 6 ft. by $^3/_8$ in. thickness up to 9 ft. by $^3/_8$ in. thickness.

All standard machines will handle diameters up to 40 in. and special machines can be built for larger diameter work. It is available with tracks to fit any standard type automatic welding head and can also be obtained with water cooling on the main backup bar when desired.

This machine can also be used for welding of flat sheets when equipped with proper feed and discharge tables.

WELDING POSITIONER CUTS FABRICATION COSTS

McQuay, Inc., Minneapolis manufacturer of air conditioning and commercial refrigeration equipment, has cut brazing time of cooling coils by the use of a welding positioner.

An unusual feature of the P&H Welding Positioner is the addition of a self-leveling table on the top for the operator to stand on. This permits him to braze all points without having to change position, as he can rotate and change the angle of tilt of the coil from the table. A push-button control is provided for all operations of the positioner, including power elevation of the table which makes it possible to position the operator as well as the work. This exclusive P&H feature saves time for the operator and ends waiting time for crane service as the table may be raised or lowered with the work in place.

The coil shown mounted on the positioner weighs approximately 1300 lb. and measures 7 x 9 feet. The positioner is a P&H Model WP-3 having a dual capacity of 3000 and 4600 lb. Information on the welding positioner can be obtained from the

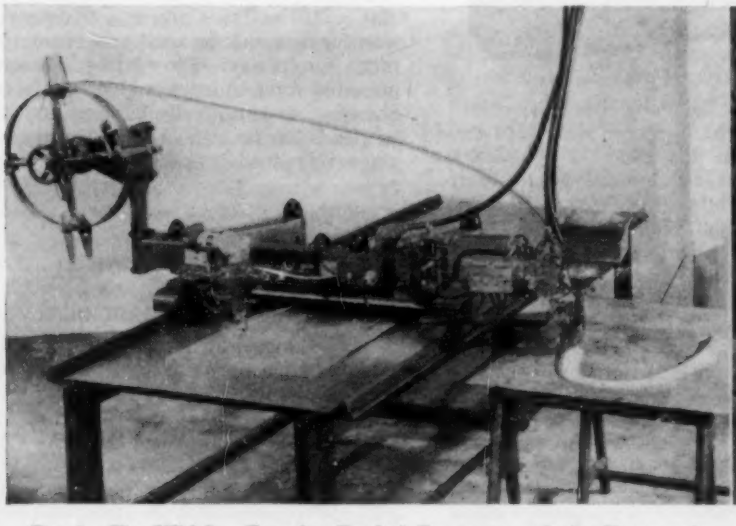
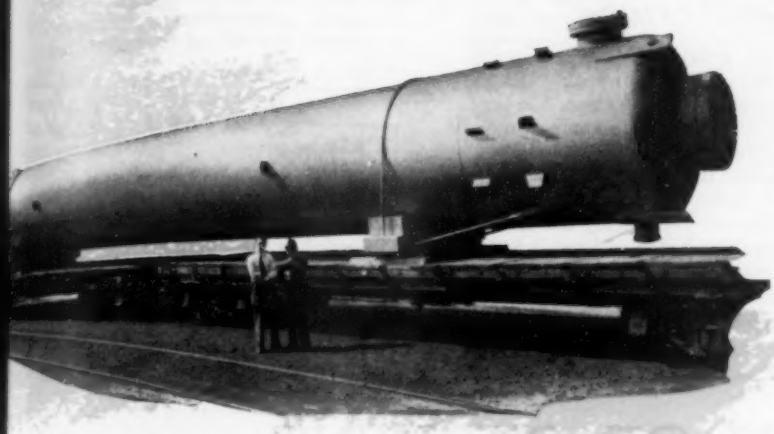


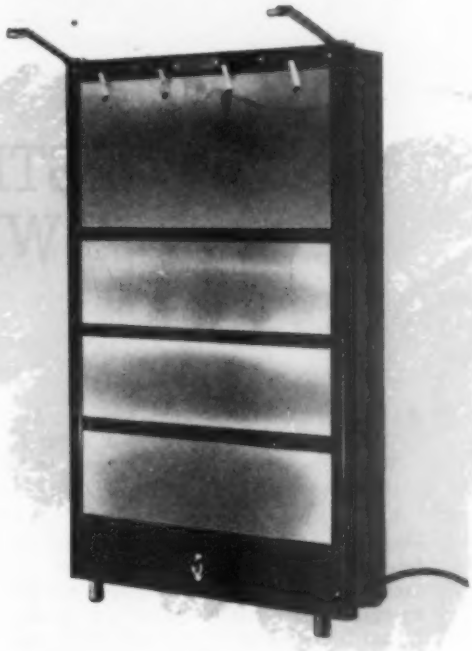
Fig. 1—The WM-6, a Templet Guided Carriage, with the Unionmelt Welding Head, Can Make Welds of Any Outline

Fig. 2—Welding Domestic Fuel-Oil Tanks with the WM-6 Shape-Welding Machine

Welding reaches new levels of soundness . . .



To get the facts on the internal condition of a weld . . . to provide an almost perfect control for assuring homogeneous welds . . . to give the welding engineer (and, where necessary, the customer) a permanent record of the job—use radiography.



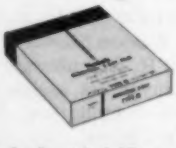
. . . when critical examinations are made with radiography

Radiography provides more information about the internal condition of a weld than is obtainable in any other way. It shows up irregularities, reveals lack of penetration, burned-through areas, gas and slag pockets, undercuts and other weaknesses . . . shows the welder everything he needs to know.

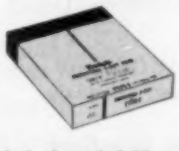
For maximum radiographic visibility . . . use Kodak Industrial X-ray Films . . .

Kodak Industrial X-ray Film, TYPE A...for x-ray and gamma-ray work in sections where fine grain and high contrast are desirable for maximum sensitivity at moderate exposure times.

Kodak Industrial X-ray Film, TYPE K...designed for gamma-ray and x-ray radiography of heavy steel parts, and of lighter parts at limited voltages where high film speed is needed.



Kodak Industrial X-ray Film, TYPE M...first choice in critical inspection of light alloys, thin steel at moderate voltages, and heavy alloy parts with million-volt equipment.



Kodak Industrial X-ray Film, TYPE F...with calcium tungstate screens—primarily for radiography of heavy steel parts. For the fastest possible radiographic procedure.

They provide the high radiographic sensitivity—the combination of speed, contrast, and fine grain—required for the detail visibility you need in critical examination of welds.

For complete information on the types best adapted to your job, see your local x-ray dealer or write to

Eastman Kodak Company
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RADIOGRAPHY

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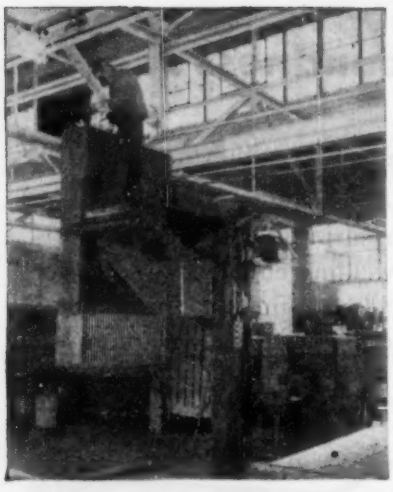
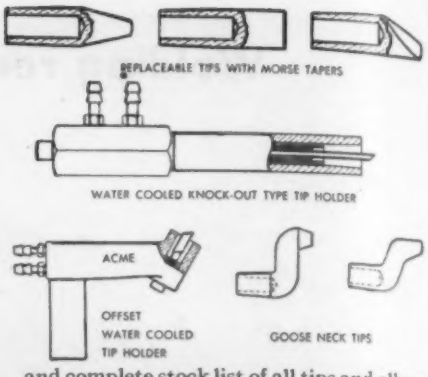


Harnischfeger Corp., Welding Division, 4400 West National Ave., Milwaukee 14, Wis.

NEW RESISTANCE WELDING ALLOY CATALOG

Widespread development of resistance welding in the past several years calls for parallel development of alloys used in spot welder tips, electrodes, flash and projection welding dies and seam welder disks.

Acme Electric Welder Co.'s Alloy Catalog No. 502 depicts a complete new line made from Acmeloy, Superloy and Stainaloy. New items include a variety of special gooseneck tips, offset tip holders and seam welder disks, also a complete line of standard tips and holders. Price, specifications and complete stock list of all tips and alloys are included in the Catalog.


REPLACEABLE TIPS WITH MORSE TAPERS
WATER COOLED KNOCK-OUT TYPE TIP HOLDER
ACME
OFFSET WATER COOLED TIP HOLDER
GOOSE NECK TIPS

This Catalog may be obtained by writing to Acme Electric Welder Co., 2618 Fruitland Rd., Los Angeles 11, Calif.

ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed Copies of patents may be obtained for 25¢ from the Commissioner of patents, Washington 10, D. C

2,436,387—MULTIPLE ELECTRODE ARC WELDING—Isaac Harter and Evan F. Wilson, inventors, Akron, O. assignors to the Babcock & Wilcox Co. (10 Claims)

In this weld method, a plurality of electric arcs, with a uniform phase difference of less than 180° between the arcs, are maintained in a weld zone and are energized from a single polyphase source. Metal is independently supplied to each arc, the voltages of which are individually controlled.

2,436,617—WELDING TORCH—Tony Svet, inventor, Cleveland, Ohio. (9 Claims)

In Svet's welding torch, a body, with a mixing chamber therein, has a nozzle attached thereto. Two passages deliver gas into the chamber and an axially movable tubular member positions a valve for controlling one of such passages. An axially movable valve is within the tubular member for controlling the second passage.

2,436,760—CONTROL VALVE UNIT FOR WELDING APPARATUS—Henry T. Platz, inventor, Detroit, Mich., assignor to Briggs Manufacturing Co., Detroit, Mich. (6 Claims)

A special fluid pressure control valve unit is disclosed in the patent.

2,436,863—WELDING APPARATUS—Stanley M. Humphrey, inventor, Warren, Ohio, assignor to Taylor-Winfield Corp., Warren, Ohio. (14 Claims)

The patented welding apparatus includes a capacitor and a welding circuit adapted to be energized by the capacitor and including a pair of welding electrodes. Means are provided for moving the electrodes apart upon completion of a welding cycle and additional means are provided to short the electrodes prior to moving same apart.

2,436,867—WELDING ROD—Richard K. Lee, inventor, York, Pa., assignor to the McKay Co., York, Pa. (4 Claims)

A welding rod comprising a core wire and coating of such a composition so as to deposit weld metal comprising specified small quantities of carbon, silicon, nickel, manganese and chromium from about 16.5 to 22%. The balance of the weld metal is substantially all iron except for usual impurities and the weld metal being at least, in part, austenitic and being rapidly work hardenable.

2,436,884—COATED WELDING ROD—Johann Diedrich Fast, inventor, Eindhoven, Netherlands, assignor to Hartford National Bank and Trust Co., Hartford, Conn. (7 Claims)

The welding electrode of the patent is particularly adapted for electric arc welding and its core has at least 50% iron content. A slag forming coating is on the core and contains a reducing agent including a sufficient percentage of material other than magnesium for preventing oxidizing of the iron metal during welding. The coating also contains an arc-preserving agent consisting of at least about 90% of magnesium for preventing extension of the arc during welding.

2,437,633—ELECTRIC WELDING GROUND—Oliver R. Abram, inventor, Glendale, Calif. (1 Claim)

A special ground connector, including a housing having an open bottom with a horseshoe type electromagnet carried inside the housing and extending there below, is covered in the patent. Guide arms are carried by the electromagnet and a contact pin is vertically movably supported in the guide arms and insulated therefrom. A spring urges the contact pin into yielding engagement with the work.

2,437,652—WELDING ROD HOLDER—Rupert R. Reddick, inventor, Oakland, Calif. (1 Claim)

A special type of welding rod holder is covered in the patent and the holder includes a ferrule that is received within a tubular handle and aids in controlling the action between a fixed jaw of the holder and a movable jaw carried thereby.

2,437,740—REPLACEABLE NOSE FOR SPOT WELDING TIPS—Thomas M. Haynes, inventor, Indianapolis, Ind., assignor to P. R. Mallory & Co., Inc., Indianapolis, Ind. (6 Claims)

Haynes's patented welding tip has a body adapted to fit into a tip holder with the shank of the tip having a cavity formed therein for circulation of cooling fluid therethrough. A removable nose for the tip is provided and has a surface complementary with the head of the tip. A clamp member forces the complementary surface of the removable nose into intimate contact with the tip to form a joint having a high thermal and electrical conductivity. This joint is between the welding face and the cooling fluid cavity in the welding tip shank.

2,437,840—METHOD OF MULTIARC WELDING—Colby Weston Steward, Kenmore, and Malcolm R. Rivenburgh, Williamsville, N. Y., inventors, assignors to Cornell Research Foundation, Inc., New York City (8 Claims)

This novel welding method comprises the steps of preheating an electrically conductive workpiece and metallic welding rod by an electric arc until fusion has commenced, and thereafter striking a second electric arc between the welding rod and the workpiece in the atmosphere of the first arc. The arcs are moved in a unitary manner, and the first arc is formed by

alternating current whereas the second arc is actuated by direct current.

2,438,155—Process of Welding Metal Bodies by High-Frequency Electric Heating of Dielectric Material Therebetween—Isaac M. Diller, inventor, Glen Ridge, N. J. (5 Claims)

Diller's patented process includes the step of juxtaposing the edges of two metal bodies which are to be welded together and establishing between the edges a zone having the qualities of a highly imperfect dielectric. An electric current of a frequency of at least one megacycle per second is passed through the dielectric zone to heat the material therein so as to fuse the edges of the bodies into a weld.

2,438,170—Gas Heating Torch—Howard G. Hughey, inventor, Fanwood, N. J., assignor to Air Reduction Co., Inc., New York City (3 Claims)

This gas torch includes an elongated block which has two longitudinal channels formed therein. The one channel extends into the block from the discharge face thereof and has an insert positioned therein and forming with the other channel a gas distributing chamber. The insert has a row of slots in a side face thereof to form with an adjacent sidewall of a block a longitudinal series of jet passages that communicate with the distributing chamber. The torch also has a member for supplying gas to the distributing chamber.

2,438,262—Electric Welding Machine—Harold Gladstone Watkin, inventor, Liverpool, England. (3 Claims)

This patent specifically covers a special type of a timing switch mechanism adapted for use with a welding machine. The switch includes a spring control camshaft which controls a cam that closes contact means and controls the length of time that such contact means remain closed.

2,438,279—Electrode Holder—James D. Forney, inventor, Fort Collins, Colo. (3 Claims)

The patented electrode holder includes a tubular handle having a conductor extending therethrough and carrying at its front end an electrode clamp member. The tubular handle comprises the other conductor of the circuit and a rod-like conductor is secured to the handle for rocking movement about an axis parallel to the axis of the handle. The rod-like conductor on the handle has a lever associated therewith for rocking such conductor and an electrode clamp carried thereby with respect to the electrode clamp member positioned by the first mentioned conductor.

List of New Members

March 1 to March 31, 1948

ATLANTA
Guillot, Edward (B)
Stewart, Jack (D)

BRIDGEPORT
Creel, John E. (C)
Gray, Arthur (C)
Millen, Thomas (C)
Perry, George F. (C)
Seymour, William A. (C)

CHATTANOOGA
Ward, Charles Theodore (C)

CHICAGO
Barry, Robert A. (B)
Bennett, Clare (C)
Cook, Walter L. (B)
Geyer, V. L. (C)
Goszczycki, Arthur (B)
Hjulin, Paul (C)
Kotansky, Cyril M. (C)
Martin, Howard B. (C)
Schiebel, Roy A., Jr. (C)
Wiwat, Ray S. (B)

CINCINNATI
Bennett, Lowell Wm. (B)
Broughton, Robert O. (C)
Jones, Charles H. (C)
Kapson, Harry H. (C)
Nadeau, Daniel (C)
Thorton, James P. (C)

CLEVELAND
Leiter, Raymond B. (C)
Lewis, John Frank (C)
Steel, O. R. (C)

COLORADO
Kob, H. Howard (C)

COLUMBUS
Ferguson, Dennis O. (B)

DAYTON
Brown, Richard L. (C)
Garlitz, David H. (C)
Lane, Dewey (C)
Spahr, Paul E. (C)

DETROIT
Anderson, Richard V. (B)
Armstrong, Charles H. (B)
Barlow, Robert (A)
Goring, John W. (C)
Holland, Frank H. (C)
Kassemeyer, Edward G. (C)
Keating, La Verne J. (B)
Kinsman, Shephard (C)
McKeen, Alexander C. (D)
Richards, Gerald W. (B)
Schmidt, Carl H. Jr. (C)
Smith, J. Randolph, Jr. (C)
Wheeler, Harvey G. (C)
Whitley, Joseph L. (C)

HARTFORD
Kot, Emil J. (C)

INDIANA
Johnson, Mark O. (C)

INLAND EMPIRE
Blackford, L. J. (B)
Moss, John H. (D)

KANSAS CITY
Payne, Joseph M. (B)
Sargent, Laurice A. (C)
Schmidt, Dallas G. (B)
Smith, Harold L. (B)
Walker, Sam J. (B)

LONG BEACH
Breese, Charles L. (C)

LOS ANGELES
Burnside, True (C)
Cortright, Jack Allen (C)
Sims, G. M. (B)

MAHONING VALLEY
Barrow, James R. (B)
Cordner, James H. (C)
Miller, Howard B. (C)

MARYLAND
Sipp, George F. (B)
Wallace, William B. (C)

MICHIANA
Handrock, W. H. (C)
Hecht, Herman J. (C)
Keech, Earl M. (C)

MILWAUKEE
Helm, Fred J. (B)
Starost, John C. (B)
Wendlandt, G. E. (B)

NEW JERSEY
Bodnar, Andrew S. (B)
Corson, Clarence B. (B)
Edell, Harold E. (B)
Hansen, Christen (B)
Holbrook, Gordon G. (C)
Krel, Frank P. (B)
Krel, Peter F. (B)
Lewis, Paul B. (C)
Ordemann, John W. (C)
Romano, Ralph (B)

NEW ORLEANS
Haygood, Paul E. (C)
Horton, Earl (C)
Voorhies, Pierre B. (D)

NEW YORK
Thomas, Sheldon (B)
Wiener, Dr. Ernst (C)

NORTHWESTERN PA.
Holtz, J. A. (C)

OKLAHOMA CITY
Davee, Levi H. (C)
Burleson, Merle (C)
Kinser, Arthur D. (D)
Kixmiller, Jake W. (C)

PEORIA
Seid, Howard R. (D)

PHILADELPHIA
Flynn, Harold F. (C)
Gallagher, Maurice J. (C)
Gramm, Frank G., Jr. (C)
Levy, Marvin Baker (C)
Litteral, Robert B. (C)

PITTSBURGH
Gray, Richard T. (D)
McCague, Henry Hugh (C)
Pooley, Paul E. (D)

PORTLAND
Linton, Fred W. (D)

ROCHESTER
Douglas, William P., Jr. (C)

ST. LOUIS
Brugioni, Delmo L. (D)
Cole, Leland E., Jr. (C)

SAN FRANCISCO
Anderson, E. E. (C)
Barrie, Marshall (B)

SOUTH TEXAS
Ford, William Roy (D)
Huggins, Edward M. (D)

SYRACUSE
Blankmeyer, R. O. (C)
Folkman, Robert L. (D)
Greene, Raymond J. (C)
Griffin, Ivan H. (C)
Heise, Walter E. (C)
Kossar, Sanford A. (D)
Kuzmich, Michael (C)
Malkocoglu, Lutfullah (D)
Moon, Albert H. (D)
Sheptak, Nicholas (D)

TOLEDO
Flick, John Robert (D)

WASHINGTON
Taylor, Frederick W. (D)

WESTERN MICHIGAN

Antflink, Gerald B. (C)
Eyestone, John D. (C)
Fox, A. Thomas (C)
Hewes, Alvin C. (C)
Kemp, Robert (B)
Lane, Everett L. (C)
Van Loo, William R. (C)
Wagner, Paul W. (C)
Wilcoxson, R. B. (B)

WESTERN NEW YORK

Fasolino, Alfonso (C)
Fasolino, Peter (C)
Graves, Edward J. (B)
Hedley, Richard P. (B)
Marshall, James J. (B)
Schemel, Milton P. (C)

WICHITA

Borror, Martin A. (D)
Dyer, Alvah F. (D)
Jacobs, Frank, Jr. (D)

WORCESTER

Bonczek, Chester S. (C)
Slukis, Anthony (B)
Smelewicz, Frank A. (C)

YORK-CENTRAL PA.

Pfeifer, Edmund (B)

NOT IN SECTIONS

Blagg, Lester L. (D)
Grady, T. Wesley (B)
Harris, Harry Sims (C)
Kirkness, Alan G. (B)
McDermott, Harold E. (B)
Wachtel, A. H. (C)
Weismantel, Elmer E. (D)
Zarebski, Inz. Henryk (B)

SECTION ACTIVITIES

BOSTON

The March 8th dinner meeting was held at the Engineers Club, Boston. Speaker at the technical session was James R. Craig of The Linde Air Products Co., Boston. Mr. Craig spoke on "The Heliarc Process of Welding." Refreshments were served after the meeting.

BRIDGEPORT

The seventh meeting of the year was held on March 18th at The Candlelite. Steak dinner preceded the technical meeting. Automatic Welding was the subject presented by J. R. Craig of The Linde Air Products Co. Mr. Craig's talk covered the automatic phases of submerged-melt welding, heliarc welding and gas welding.

CINCINNATI

The regular monthly meeting was held on March 23rd at the Engineering Society Headquarters. Paul H. Setzler, Consulting Engineer, Lima-Hamilton Corp., spoke on "Welding—Its Fatigue Values and Proper Application." A dutch lunch and entertainment was provided for the members and guests.

COLORADO

The March 9th dinner meeting was held at the Silver Wing Inn, Denver. L. D. Erb, Vice-President, Metallizing Specialties Co., Denver, was the speaker at the technical session. Mr. Erb spoke on the subject "Metallizing." A film entitled "Steel Horizons" was shown through the courtesy of the Allegheny-Ludlum Steel Co.

DAYTON

At the March 24th meeting held at the Engineers Club, John Blankenbuehler, program chairman, collaborating with Earl Garber, showed a group of welding movies. Announcement was made at this meeting of the selection of the Nominating Committee and the listing of the Membership Committee and Program and Publicity Committee for the 1947–1948 season.

DETROIT

The March meeting of the Detroit Section was held on Friday, March 12th, at the Engineering Society of Detroit. The topic for the evening was "Welding with the Inert-Gas-Shielded Arc." Chairman Al Last introduced to the 205 members and guests present the speakers for the evening as follows: Frank McGuire, Jr., Division Service Engineer, The Linde Air Products Co., Chicago, and R. W. Tuthill, Development Engineering Dept., General Electric Co., Holyoke, Mass. Great interest was shown in the equipment and welding process as explained by Mr. Tuthill and Mr. McGuire. The discussion period following the speakers was one of the best the Section has had this year. Members of the audience bombarded Mr. Tuthill and Mr. McGuire with so many questions that the meeting would have lasted all night had not the Chairman secured a promise from the speakers to return next fall with more information on the same subject.

The seventh monthly meeting of the Saginaw Valley Division of the Detroit Section, was a plant visitation at the Dow Chemical Co., Midland, Mich. A near record turnout of 212 guests and members attended what proved to be an outstanding demonstration of welding technique covering the welding of magnesium, aluminum, Monel, inconel, stainless steel and copper. The visitors witnessed arc welding, high frequency arc in an argon atmosphere, atomic hydrogen, d.-c. welding in helium, and special flame and brazing applications on the above metals. In addition, metal spraying was demonstrated for the repair of machine parts.

Simon Greenberg, National Technical Secretary, was in attendance at the meeting. G. O. Hoglund, Vice-President of District 4, was a visitor and gave a short talk on the benefits and responsibilities for members of the SOCIETY.

HARTFORD

R. A. Powley, Supervising Process Engineer, Sheet Metal and Welding Sections of the Pratt & Whitney Aircraft Corp., told of his experiences in British industry during World War II, at the March 18th dinner meeting held in the Whitlock Manufacturing Co. Cafeteria, Elmwood, Conn. Mr. Powley has been in the United States for a short period of three months, having been connected with the Bristol Aircraft Co. in England.

Installation of officers for the 1948–49 Season will take place at the May 21st meeting.

INLAND EMPIRE

The following is a résumé of activities of this Section since November, 1947.

December, 1947 meeting was held at Spokane Oxygen Service in Spokane, Wash. The speaker, H. G. Phelps, Western Divisional Manager, All-State Welding Alloys Co., delivered an address on the subject, "The Proper Application of Low-Temperature Welding and Brazing Alloys." His address was accompanied by an actual demonstration of the techniques employed in the application of these alloys. Mr. Phelps ably demonstrated his ability to present his subject and successfully answered all questions put by members of his audience. Mr. Phelps permitted any who desired to apply the various alloys and test the welds made in a variety of ways. Refreshments of the evening were furnished by Mr. Douglas.

The January meeting was held at the Coeur d'Alene Hotel in Spokane, Wash. The dinner meeting was followed by a discussion of correspondence and projected programs. Then an address was heard on the subject, "What We Have Learned from Our Studies of Residual Stresses," presented by Prof. E. Paul DeGarmo of the University of California. Professor DeGarmo illustrated his paper by an extensive series of slides which were much enjoyed by all. The conclusion of Prof. DeGarmo's address called forth much discussion.

The February Jamboree meeting was held over until March 5th and was held at the Log Cabin Inn in Coeur d'Alene, Idaho. Buffet lunch was served and entertainment offered by guitar, accordion and piano solos and ensembles. This was a "get-together" meeting and much enjoyed by all attending.

KANSAS CITY

The present officers and directors of the Kansas City Section, as well as past officers and directors, were called together on March 3rd to meet with Joe Magrath, Executive Secretary, for a general discussion on A.W.S. activities, present and future. After a brief discussion with Mr. Magrath, the proposed clinic or lecture course for the fall of 1948 was discussed. Mr. Magrath outlined some of the plans headquarters has for increasing membership and increasing interest so that a

larger membership would feel that they were getting their money's worth. It was believed that this meeting was very helpful in stimulating interest and it is hoped that a renewed interest will be developed beyond anything in the past.

The regular monthly meeting was held on March 18th at the Power & Light Building. Dinner at Fred Harvey's preceded the meeting. Harold Baldwin, of R. G. Le Tourneau, presented an address on "Welding Procedures." Mr. Baldwin was very practical in his talk and presented many good ideas as to welding procedures on heavy steel machinery.

LEHIGH VALLEY

The Lehigh Valley Section held its regular monthly meeting on Monday, April 5th, at Lehigh University, Bethlehem, Pa. Approximately one hundred members and guests attended the dinner which was served in Lamberton Hall.

Following the dinner, two hundred members and guests gathered in Fritz Engineering Laboratory to witness demonstrations of the new developments in the welding field. The exhibitors taking part in the program, and the methods which they domonstrated were as follows:

Air Reduction Sales, Flux Injection Cutting of Stainless Steel.

The Lincoln Electric Co., "Fleet Arc" A.-C. Welder with Arc Booster.

The Linde Air Products Co., in conjunction with Southern Oxygen Co., Heliarc Spot Welding and Heliarc Manual Welding.

Metal & Thermit Corp., Arc-Oxygen Cutting and Underwater Welding.

K. W. Ostrom & Co., The Latest in Resistance Welding Holders and Miller Electric Co.'s Spot Welder.

Powder Weld Process Co., Powder Welding, Brazing and Hard Facing.

Sperry Products, Inc., Supersonic Testing of Welds and Supersonic Measurement of Plate Thickness.

Stoody Co. and Southern Oxygen Co., Hard Facing and Applications of Stoody Alloys.

LOS ANGELES

Approximately 120 members and guests of the Los Angeles Section enjoyed an extremely interesting evening's commentary on "What the Future Holds for Welding," at their regular monthly dinner meeting held on March 18th at Scully's Cafe. Speaker for the evening was "Ted" Jefferson, Editor of *The Welding Engineer*. During the presentation of his subject, Mr. Jefferson itemized and discussed the following problems that face those interested in the advancement of welding:

Welding vs. Riveting.

Training of Future Engineering Talent for a More Complete Acceptance of Welding Among Engineering Circles.

Recognition of Welding as a Craft.

Wider Dissemination of Publicity Regarding Research and Development Activities of the A.W.S.

Educating the User of Welding in the Developments of the A.W.S. (such as Symbols, Codes, Etc.)

Second speaker for the evening was Dr. Smith of the Harnischfeger Corp., who conducted a twenty-minute discussion on the development and use of lime ferritic electrodes.

LOUISVILLE

The March meeting was a change from the usual dinner meeting and the program opened with a "Quiz" session which proved very successful as to interest shown and audience participation. Questions about various problems in connection with welding, which had been turned in by members, were submitted by the "Examiner"—C. J. Schneider, Mineweld Co. of Kentucky—to a group of "Experts," who then proceeded to answer the questions to the satisfaction of the "Judges" and the audience. The discussion was lively and enlightening.

F. R. Strate, Welding Specialist for the Air Reduction Sales Co., Technical Sales Division, New York, was the guest speaker. Mr. Strate spoke on the "Design and Application of Arc Welding Electrodes." He gave the history of the development of the various classes of arc-welding electrodes and explained in some detail the function of the ingredients that go into the rod-coatings. He also told of the proper applications for the rods, and how to choose the right rod for desired results on a particular job.

The meeting was held in the Preston Kunz Restaurant and following Mr. Strate's talk a Dutch Lunch was served.

MAHONING VALLEY

The following is a résumé of the meetings held since October.

November 13th meeting was held a Odd Fellows Hall. This was a joint meeting with A.S.M. Dinner speaker was A. D. LeMonte who spoke on the public relations at Mullins Mfg. Co. Technical session speaker was Dr. Allen of the Budd Co., who spoke on "Deep Drawing of Sheet and Strip."

January 15th meeting was held in Youngstown, Ohio. J. P. Cowie of The Linde Air Products Co., spoke on "Oxy-acetylene Pressure Welding."

February 19th meeting was also held in Youngstown, Ohio. Dr. F. R. Hensel of P. R. Mallory & Co., spoke on "Trends in Resistance Welding Here and Abroad."

March 11th meeting was held at Odd Fellows Hall, Warren, Ohio. This was joint meeting with A.S.M. A. M. Unger, Pullman Standard Car Mfg. Co., spoke on "Welding Railroad Passenger Cars."

MARYLAND

The March meeting of the Maryland Section was held in the Engineers Club of Baltimore on the 19th. The program for this meeting included a colored movie on fishing for those who already sensed spring in the air. The technical speaker was John C. Barrett, Research Metallurgist, Engineering Labs., Glenn L. Martin Co., Baltimore, who spoke on "Welding in the Aircraft Industry." Also on hand was a display and demonstration of nondestructive methods of testing metal parts for defects, featuring the Magnaflux and Zyglo processes.

MICHIANA

The Michiana Section held their March meeting on the 19th at the Bendix Legion Hall in South Bend, Ind., with a very interesting lecture by J. J. Vreeland, Metallurgical Engineer, The Chase Brass & Copper Co., Waterbury, Conn. Mr. Vreeland's talk was a very accurate description of the possibilities and limitations in welding copper and copper alloys. He described the difference between electrolytic and oxygen-free copper and why the latter welds so much better than the former. Acetylene and carbon arc are the methods preferred on both copper and alloys. Welds made in yellow brass and naval brass were also discussed.

MILWAUKEE

The February meeting of the Milwaukee Section was held on the 27th at the Ambassador Hotel, with forty present at dinner and ninety attending the technical meeting. The dinner was followed by a film "Adventures in Research" which was shown through the courtesy of the Westinghouse Electric Corp. and presented the theory of many of the electronic devices which have been recently developed. This was a very interesting film which made some of these electronic devices seem comparatively simple.

The technical talk was by E. I. Larsen, Chief Metallurgical Engineer of P. R. Mallory & Co. of Indianapolis. His subject was "Electrode Materials Used in Resistance Welding." Mr. Larsen discussed the application of the various grades of resistance alloys and the advantages of each type for specific applications. Mr. Larsen's talk was very well received, as indicated by the number of questions following his presentation. The talk was illustrated with a number of interesting slides.

The first part of the educational course being conducted by the Milwaukee Section was presented Monday evening, March 1st, at Marquette University. This was a panel discussion on Manual Arc Welding, with questions having been sent in on postcards before the meeting. Questions were also asked from the floor during the discussion. A panel of six experts, consisting of Mr. Garriott of the Ampco Metal Co., Dr. Larson of the Allis-Chalmers Co., Mr. Brekelbaum of the Harnischfeger Corp., Mr. Hippe of The Linde Air Products Co., Mr. Flocke of Trent Tube Mfg. Co., and Mr. Burks, Jr., of the Traction Co. These men answered the questions which had been sent in on the cards and also those asked from the floor. Approximately 125 were present at the meeting and judging by the number of questions that were asked, this topic was one of interest to most of these present. Two other similar panels were held on consecutive Monday nights. These are reported later.

The Milwaukee Section entered a team in Detroit's "Quiz the Experts" night on February 13th at Detroit. Milwaukee's team consisted of Mr. Chyle of the A. O. Smith Corp., Mr. Brekelbaum of the Harnischfeger Corp., Dr. Larson of Allis-Chalmers and J. Welch of Cutler Hammer Co. The Milwaukee team came in second, losing by two points on the very last question of the program.

The March 19th meeting was held at the Ambassador Hotel with about forty-five at dinner and over one-hundred at the technical session. Following dinner a thrilling motion picture of deep sea fishing (including an incidental whale) was shown. This film was especially well received.

The technical talk was by A. N. Kugler of the Air Reduction Sales Co., New York. and covered "Brazing and Braze Welding." Mr. Kugler discussed briefly the definitions of these terms before going into an explanation of the uses of each. Many of the applications were illustrated with slides. In his final discussion Mr. Kugler paid his respects to the misnomer "bronze" as applied to a 60–40 *brass* welding rod.

At the conclusion of the talk there was some animated discussion of the fine distinction between brazing and braze welding and apparently without complete conviction of some members of the value of such a distinction. Mr. Kugler's talk was of special interest because of the examples of mechanization of some brazing operations that had been accomplished.

The second session of the Milwaukee educational lecture series, "A Symposium on Welding," was held on March 8th. The second session was devoted to Automatic Arc Processes and the following served as a panel of experts: E. Morris, The Linde Air Products Co.; L. J. McPhee, Whiting Corp.; L. J. Larson, Allis-Chalmers Mfg. Co.; and J. J. Chyle, A. O. Smith Corp.

The March 15th lecture covered "Gas-Shielded Arc Welding, Gas Welding and Brazing." The panel for this session consisted of: F. McGuire, The Linde Air Products Co.; L. G. Pickhaver, General Electric Co.; J. J. Chyle, A. O. Smith Corp.; and E. Soicka, Viking Welding Supply Co.

There was good attendance at all of the meetings, and plenty of questions to be answered.

NEW JERSEY

The regular monthly meeting of the New Jersey Section was held at the Essex House, Newark, N. J., on March 16th. After dinner a film was shown entitled "Alloy Steels—A Story of Their Development." This is a sound picture made by the Bureau of Mines, in cooperation with the Climax Molybdenum Co.

Speaker at the technical session was Dr. Samuel L. Hoyt, Technical Advisor, Battelle Memorial Institute, Columbus, Ohio. Dr. Hoyt's subject was "Steels for Resistance Welding." Starting with the accidental discovery of resistance welding, Dr. Hoyt reviewed the development and early use of butt welding, spot welding and flash welding, showing how the few simple steel requirements changed to a more comprehensive specification for steels and welding conditions as severe applications became increasingly more critical.

NEW YORK

The New York Section played host to the Metropolitan Section of the A.S.C.E. at their meeting on March 17th. Commander L. C. Coxe, U.S.N., Head of the Design Division, Bureau of Yards and Docks, and A. Amirikian, Structural Engineer, Bureau of Yards and Docks, spoke on "Structural Welding Practices, Present and Proposed." Commander Coxe described some of the construction work done during the war and pointed out how welded fabrication had resulted in substantial savings in steel. His talk dealt primarily with buildings and floating dry docks.

Mr. Amirikian spoke on the "proposed" phase of the subject. He described a wedge-type beam which simplifies the structural design problems. By means of slides he showed how the wedge beam is applicable to many types of building construction. Although work on the first building which was designed to use this beam has been temporarily suspended, Mr. Amirikian reported that their design calculations showed a saving of 40% or more in the steel tonnage and a 35% saving in cost. He reported that the erection time was about the same as for the conventional I-beam. Several of the engineers present asked questions about the proposed wedge-type beam.

Arrangements for the meeting were in charge of A. E. Poole of The Hallen Co. who is a member of the Metropolitan Section, A.S.C.E., as well as the New York Section, A.W.S. E. H. Roper, Vice-Chairman of the New York Section, presided and H. O. Locher, president of the Metropolitan Section of the A.S.C.E., acted as Technical Chairman. Refreshments were served at the end of the meeting.

Plans have been completed for a visit to the Air Reduction Laboratories at Murray Hill, N. J., on Saturday, May 22nd. It is hoped to limit the attendance to 200. Charles Kandel is in charge of all details of the trip.

NORTHWEST

The seventh meeting in the 1947–48 season was a three star program. Dinner in the Dude Room, Covered Wagon, was preceded by a "Happy Half Hour," the hosts of which were the Machinery & Welder Co. and the General Electric Co. Speaker was L. G. Pickhaver, Welding Engineer, Chicago Engineering Division, General Electric Co. His subject was "Automatic Processes of Welding." Mr. Pickhaver used slides to illustrate his subject and, in addition, a new sound, colored movie "More Power to America" produced for the General Electric Co. was shown.

NORTHWESTERN PENNSYLVANIA

"Welding Aluminum—Including Inert Gas-Shielded Arc Method" was the subject of the March 23rd meeting held at the General Electric Community Center, Erie, Pa. Society hour and dinner preceded the meeting. The speaker was Charles Bruno, Welding Engineer of the Technical Service, Reynolds Metals Co. Mr. Bruno has had wide experience in the welding field. At present his services as welding engineer are being made available to help Reynolds customers with their welding problems.

PASCAGOULA

The March 31st meeting was held at the Pascagoula Country Club, Pascagoula, Miss. J. A. Farr, Chairman of the Pascagoula Section, spoke at the dinner on the activities of the Section. Speaker at the meeting was A. F. Blumer, Chief of Metallurgical Service & Welding Inspection, Esso Standard Oil Co., Baton Rouge, La. Mr. Blumer spoke on "Welding in the Petroleum Industry."

PHILADELPHIA

Regular monthly meeting was held on Monday, March 15th, at the Engineers Club. F. E. Garriott of Ampco Metals, Inc., Milwaukee, Wis., spoke on the subject, "Welding of Copper and Copper Alloys."

A Panel Discussion was held on Friday, April 2nd, at the Engineers Club. The subject discussion was on "Factors Influencing Fracture of Metals," and was presented by Capt. Wendell P. Roop, formerly of the U. S. Navy Basin, now Research Director, Swarthmore College.

PITTSBURGH

The March meeting was held on the 17th at Mellon Institute of Industrial Research. Dinner at the Hotel Webster Hall preceded the meeting. Speaker at the technical session was D. C. Boltz, Metallizing Engineering Co., Inc., Long Island City, N.Y. Mr. Boltz' subject was "Metallizing and Its Industrial Uses," and was of interest to all.

PUGET SOUND

The March 29th meeting of the Puget Sound Section had as its speaker T. B. Jefferson, Editor of *The Welding Engineer*. His subject was "What the Future Holds for Welding." Four problems confronting the welding industry were discussed, namely:

Welding vs. Riveting.
Problems of Locked-Up Stress.
Consideration of Welding as a Trade or a Tool of the Trade.
The problem of Educating the Public to the Advantages of Welding.

The necessity for sensible provisions for welding and building codes were stressed. Mr. Jefferson also mentioned the rapidly increasing use of welding on various types of structural material, such as aluminum and magnesium, and also on plastics, die cast material and glass.

ROCHESTER

The next educational meeting—a practical and instructive program of demonstrations and discussions—on weldability, will be held on May 15th, in the Engineering Building, University of Rochester, 7:45 P.M.

The regular monthly meeting was held on Thursday, April 1st, in Room 210, Engineering Building, University of Rochester. Dinner at the River Campus, University of Rochester, preceded the meeting. A lecture demonstration was conducted by the Education Committee of the Rochester Section. Subject: "Characteristics of Some of the New Electrodes." A U. S. Bureau of Mines' movie "A Story of Texas and Its Natural Resources" was shown.

SAN FRANCISCO

T. B. "Ted" Jefferson, Editor of *The Welding Engineer*, was the speaker at the March 22nd dinner meeting held at the Engineers Club. Mr. Jefferson's subject was "What the Future Holds for Welding." Mr. Jefferson spoke on the recent welding developments and what to expect of them in the coming years. He also discussed the various new materials to be welded, and the problems that face those who are involved with welding.

SOUTH TEXAS

The March 5th meeting held in Houston Tex., was addressed by John Randall, Welding Supervisor, Research Dept., Ford Motor Co. Mr. Randall's subject was "Hydrogen Embrittlement." Mr. Randall said that the problem of hydrogen in welds is still one of the primary concerns of many research organizations, and he expressed the opinion that present day theories concerning this problem may be considered revised before all the facts are proved. In the discussion that followed the lecture Mr. Randall was led into a comparison of welding developments and techniques in Germany and the United States.

TOLEDO

The March meeting of the Toledo Section was held on the 9th in the Toledo Room, Commodore Perry Hotel. R. C. Singleton, Technical Adviser, Nelson Sales Corp., presented an interesting talk on "Nelson Stud Welding," which was accompanied by a film on the same subject.

Before the meeting a color film of "Home and Flower Garden," produced by Anthony Menna, was shown by Mr. Menna.

Following the meeting a General Electric "Excursion in Science" film was shown through the courtesy of E. V. Newman. Both films were interesting and informative.

WASHINGTON

The speaker at the March 30th dinner meeting held at Wearley's Sea Food Restaurant, was A. Valente, Electronics Sales Engineer of the Westinghouse Corp. The subject of Mr. Valente's talk was "Radio Frequency Heating." As an additional attraction at this meeting a cinema in two parts, was shown as follows. Part 1 "Induction Heating" and Part 2 "Dielectric Heating." This film is extremely interesting.

There being no additional nominations for officers or executive committee members for the 1948–49 season, the slate of the Nominating Committee was accepted as follows:

Chairman, A. Piltch, Naval Gun Factory.
Vice-Chairman, A. W. Lubbers, Westinghouse Electric Corp.
Secretary, E. M. MacCutcheon, David Taylor Model Basin, U.S.N.
Treasurer, J. C. Ritter, Bureau of Ships, U.S.N.

The new officers took over at the Annual Dinner Meeting held in the Main Dining Room of the National Airport on April 27th. The speaker for this meeting was G. Calahan. Mr. Calahan described the most recent developments in the field of electronic communication and illustrated his talk with a show entitled "Micro Wave Demonstration."

WESTERN NEW YORK

The regular monthly meeting was held on February 26th at the Hotel Touraine, Buffalo, N.Y. Approximately 150 members and guests were present to greet the National Officers and Board of Directors of the SOCIETY.

An enjoyable dinner and social hour preceded the meeting. The fact that the meeting occurred during National Brotherhood Week was opportune, in that it was possible to schedule an interesting coffee talk by Hilton Lang. Mr. Lang, Negro member of the Urban League of Buffalo, is the Executive Director of Youth Activities. His talk on welding or tying together the various races of the world more closely for the benefit of mankind was well received.

The membership of the Section enjoyed the opportunity of meeting the National Officers and Board of Directors, who were introduced following the social hour. The words spoken by our National President, H. O. Hill, were greatly appreciated. His fine evaluation of the purposes and benefits of SOCIETY membership should be well remembered by all those present.

LaMotte Grover, Welding Engineer, Air Reduction Sales Co., New York, presented the subject "Welded Steel Structures." His long and extensive experience in welded steel bridge and building construction was shown by his extensive coverage of the past, present and future status of welded construction in this and other countries. The ever-increasing interest of fabricators in welded construction was in good evidence during the instructive discussion which followed the talk.

WORCESTER

March 29th meeting was held at Svea Gille Club, Shrewsbury, Mass. Van Rensselaer P. Saxe, Consulting Engineer of Baltimore, Md., presented an interesting and factual talk on "Structural Welding," which was illustrated with slides. Discussion leaders were Francis S. Harvey, Consulting Engineer, and Wesley Proctor, Chief Engineer of the Stafford Iron Works. Guests were Willard Hedlund, Supt. of the Worcester Bureau of Buildings, and Edward T. McCann, Chief Building Inspector. Worcester has recently amended its Building Ordinance to permit the welding of structural steel.

CANADIAN

April 5th meeting of the Toronto Chapter of the Canadian Welding Society was held at Malloneys Art Gallery. T. N. Armstrong, Development and Research Division, International Nickel Co., Inc., New York, spoke on "Welding of Low Alloy Nickel Steels."

April 6th meeting of the Hamilton Chapter held at McMaster University was a "Stump the Experts" Night. Experts were W. Amos, Ferranti Electric Co., Toronto; H. Thomasson, Canadian Westinghouse Co., Hamilton; W. Kirkwood, Dominion Oxygen Co. Ltd., Toronto; and G. Foster, Canadian Welding Bureau, Toronto. Master of Ceremonies was J. J. Kelly, The Lincoln Electric Co. of Canada Ltd., Hamilton.

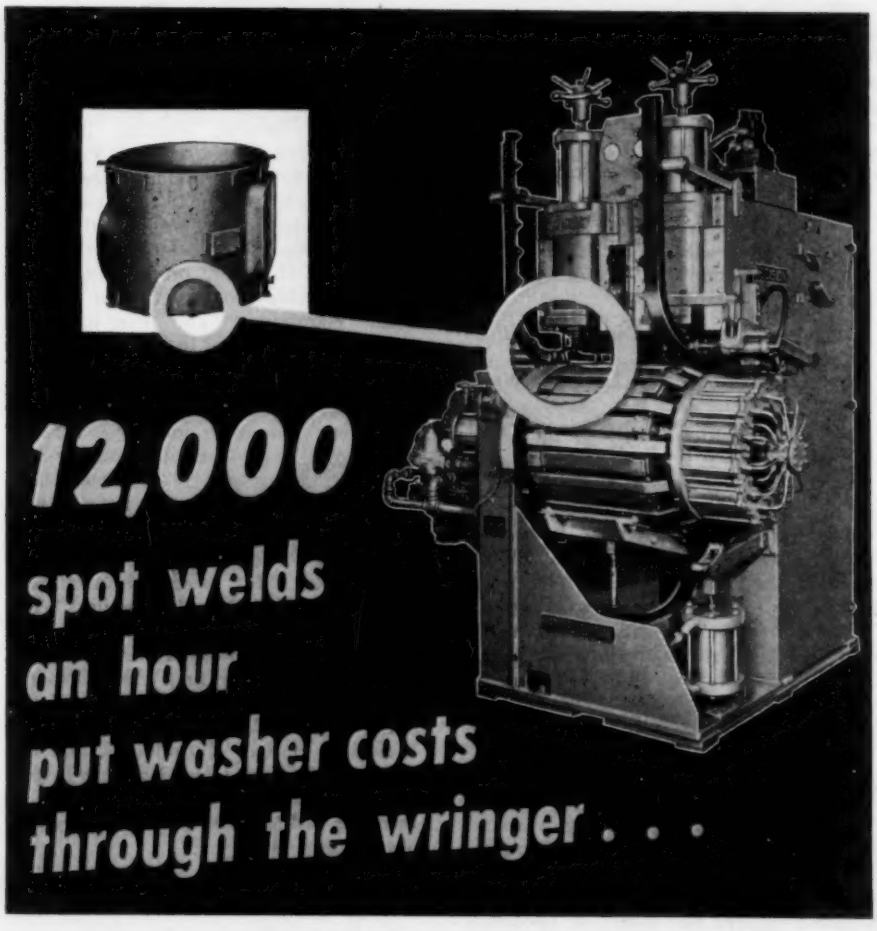
Employment Service Bulletin

POSITIONS VACANT

V-219. Sales Manager. Top-flight organizer with plenty of get-up-and-sell wanted to reorganize and expand our nation-wide sales force. A strong background in metals and industrial equipment is desirable. A future with lifetime security and better-than-average earnings. Write to us in confidence.

V-220. Welding Engineer. For heat exchanger fabricating shop in Northeastern Pennsylvania. Young man not over 30 years, with engineering degree preferred, who is qualified to establish welding procedures and sequences for carbon steel, alloy steel and non-ferrous materials. Applicants should also be capable of supervising shop inspection and testing. Essential to have likeable personality. Salary commensurate with background and experience.

V-221. Metallurgist or Engineer with metallurgical experience to serve as technical secretary for research committee and to assist in the correlation and coordination of research work through the preparation of digests and abstracts in the field of ferrous metallurgy. Experience in the steel industry desirable. Excellent opportunity. Salary attractive.



Use Ampco-Weld resistance welding electrodes with modern machines — to boost your weld-per-hour production and cut your costs

Every hour this Precision Welder completes 125 washer housings — spot welding 24 angle clips (4 welds each) on every housing. The manufacturer had hoped for 75 an hour. Resistance welding gave him nearly twice that volume.

That's why modern production methods call for resistance welding — the fastest, most economical way of joining two pieces of metal.

Men who know production welding can also tell you that it pays to use Ampco-Weld electrodes in your resistance welding set-up — for clean, strong welds, longer electrode life, and real welding economy. The Ampco-Weld line is complete with tips, wheels, dies, standard and special holders made of metals with the highest properties attainable. All products meet R.W.M.A. specifications. Call the nearest Ampco office for complete data. Write for the latest Ampco-Weld bulletin.

MEMBER RESISTANCE WELDER MANUFACTURERS ASSOCIATION R.W.M.A.

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Field Offices in Principal Cities

TEXAS BUILDING

Twelve hundred ninety tons of structural steel have been fabricated and erected as an addition to the Gulf Bldg., Houston, Tex., and shop and field welding was done under the AMERICAN WELDING SOCIETY Code for Arc and Gas Welding in Building Construction. A portion of this structure is an addition to an existing five-story wing of the Gulf Bldg., and the remainder has been erected on a new foundation to a height of twelve stories. Designed by Robert J. Cummins, Engineer, the structure makes use of rigid frame connections, with some flexible connections provided between the existing five-story structure and the new addition.

W. S. Bellows Construction Corp. is the general contractor on this latest addition to the Houston skyline, and the building design has been handled by A. C. Finn, architect. Fabrication details and welding has been supervised by Southwestern Laboratories.

AVOIDING STRESSES AND DISTORTION

Producers and fabricators of various types of equipment for all metals will be interested in the new 8-page bulletin issued by Eutectic Welding Alloys Corp.

Completely illustrating numerous methods of applications and stressing valuable means of avoiding the usual welding problems, this bulletin describes the appropriate welding rod for the particular job. For both oxyacetylene and arc users, complete descriptions of metals, techniques and applications are included.

Aviation, steel works, railroads, food industries, automotive, agricultural and a number of other production plants will find suitable welding rods outlined for each possible application.

This "Production Issue" brochure also contains a short résumé of the company's progress recently in developing the unique cutting electrode, CutTrode.

Ask for the "Production Issue" when writing to Eutectic Welding Alloys Corp., 40 Worth St., New York 13, N. Y.